2

INSTALLATION RESTORATION PROGRAM

PRELIMINARY ASSESSMENT

101st Tactical Control Squadron
and
212th Engineering Installation Squadron

Worcester Air National Guard Station
Massachusetts Air National Guard
Worcester, Massachusetts

February 1991

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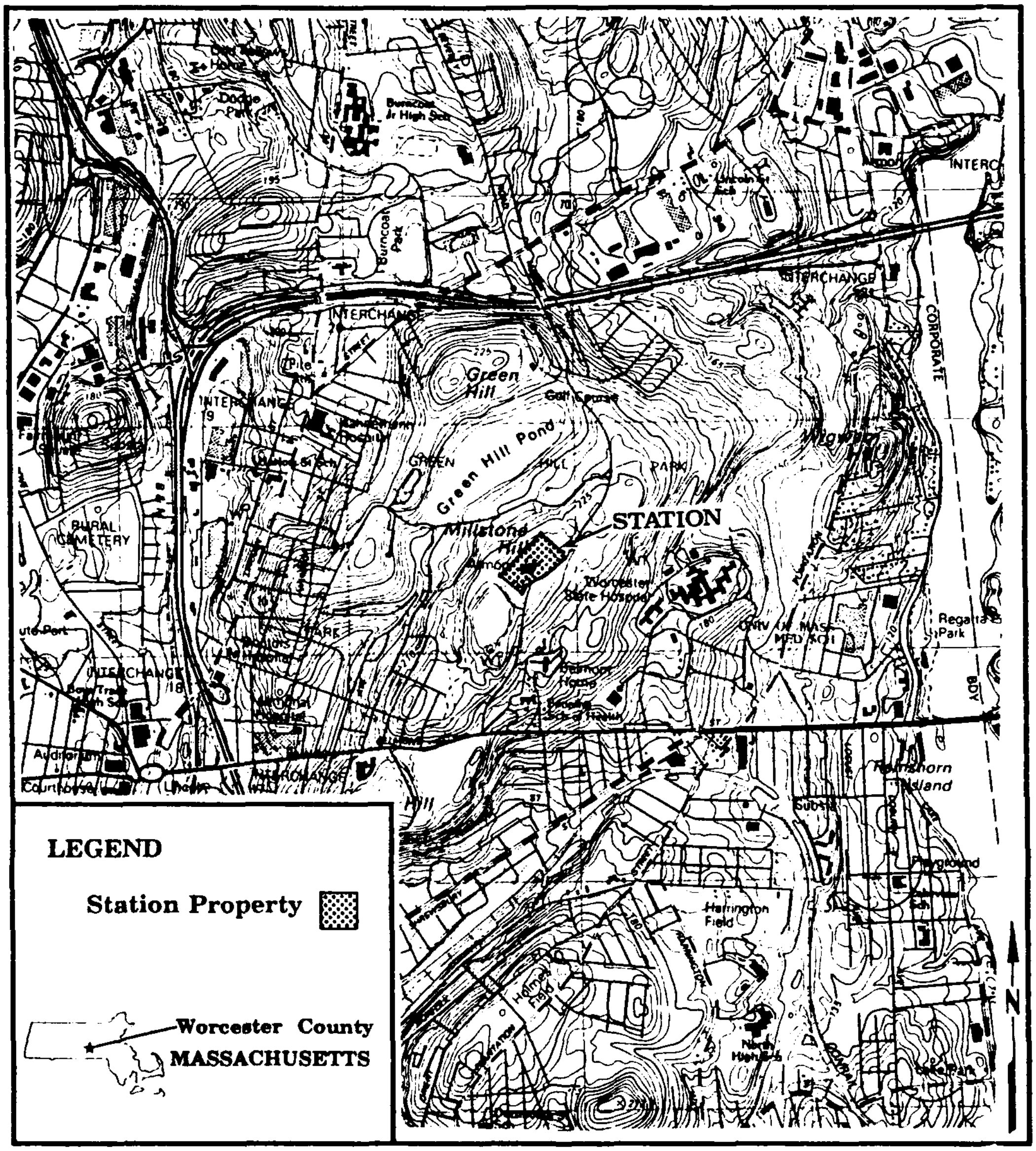

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Preliminary environmental assessment for the Worcester Air National Guard Station, as part of the Installation Restoration Program. The report relects data gathered from records review, interviews and a site visit. One site was identified as potentially contaminated and recommended for further investigation.

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INSTALLATION RESTORATION PROGRAM
PRELIMINARY ASSESSMENT

101st TACTICAL CONTROL SQUADRON
AND
212th ENGINEERING INSTALLATION SQUADRON
WORCESTER AIR NATIONAL GUARD STATION
MASSACHUSETTS AIR NATIONAL GUARD
WORCESTER, MASSACHUSETTS

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ACRONYM LIST

AGE	Aerospace Ground Equipment
AMSL	Above Mean Sea Level
ANG	Air National Guard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DoD	Department of Defense
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
EIS	Engineering Installation Squadron
EO	Executive Order
EPA	Environmental Protection Agency
FR	Federal Register
FS	Feasibility Study
GPM	Gallons Per Minute
HARM	Hazard Assessment Rating Methodology
HAS	Hazard Assessment Score
HAZWRAP	Hazardous Waste Remedial Actions Program
IRP	Installation Restoration Program
JP-4	Jet Fuel
JP-5	Jet Fuel
MOGAS	Automotive Gasoline
NGB	National Guard Bureau
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
OWS	Oil/Water Separator
PA	Preliminary Assessment
PCB	Polychlorinated Biphenyl
PL	Public Law
POC	Point of Contact
POL	Petroleum, Oil, and Lubricant
RCRA	Resource Conservation and Recovery Act
R&D	Research and Development
RI	Remedial Investigation
SARA	Superfund Amendments and Reauthorization Act of 1986
SciTek	Science & Technology, Inc.
SI	Site Investigation
TCS	Tactical Control Squadron
USAF	United States Air Force
USC	United States Code
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UST	Underground Storage Tank

EXECUTIVE SUMMARY

A. INTRODUCTION

Science & Technology, Inc. (SciTek) was retained to conduct the Installation Restoration Program (IRP) Preliminary Assessment (PA) of the 101st Tactical Control Squadron (TCS) and the 212th Engineering Installation Squadron (EIS), Worcester Air National Guard (ANG) Station [hereinafter referred to as the Station], Massachusetts Air National Guard, located in the city and county of Worcester, Massachusetts. For the purpose of this document, the Station shall include the total area leased by the 101st TCS and the 212th EIS at Worcester, Massachusetts.

The PA included the following activities:

- o an on-site visit, including interviews with a total of six persons familiar with Station operations, and field surveys by SciTek representatives during the week of May 7-10, 1990;
- o acquisition and analysis of information on past hazardous materials use, waste generation, and waste disposal at the Station;
- o acquisition and analysis of available geological, hydrological, meteorological, and environmental data from federal, state, and local agencies; and
- o the identification and assessment of sites on the Station that may have been contaminated with hazardous wastes.

B. MAJOR FINDINGS

The 101st TCS and 212th EIS have used hazardous materials and generated small amounts of wastes in mission-oriented operations and maintenance at the Station since 1957.

Operations that have involved the use of hazardous materials and the disposal of hazardous wastes include vehicle maintenance and aerospace ground equipment (AGE) maintenance. The hazardous wastes disposed of through these operations include varying quantities of petroleum-oil-lubricant (POL) products, acids, paints, thinners, strippers, and solvents.

The field surveys and interviews resulted in the identification of one site that exhibits the potential for contaminant presence and migration.

C. CONCLUSIONS

It has been concluded there is one site where a potential for contaminant presence exists.

Site No. 1 - Old Embankment/Vicinity of the Old Waste Oil Holding Area
(HAS - 71)

D. RECOMMENDATIONS

Further work under the IRP is recommended for the one identified site to determine the presence or absence of contamination.

I. INTRODUCTION

A. Background

The 101st Tactical Control Squadron (TCS) and the 212th Engineering Installation Squadron (EIS), Worcester Air National Guard (ANG) Station [hereinafter referred to as the Station] is located at Worcester, Massachusetts. Both units have been active at the Station since 1957. Both the past and current operations have involved the use of potentially hazardous materials and the disposal of wastes. Because of the use of these materials and the disposal of resultant wastes, the National Guard Bureau (NGB) has implemented the Installation Restoration Program (IRP).

The IRP is a comprehensive program designed to:

- o Identify and fully evaluate suspected problems associated with past hazardous waste disposal and/or spill sites on Department of Defense (DoD) installations and

- o Control hazards to human health, welfare, and the environment that may have resulted from these past practices.

During June 1980, DoD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM 80-6) requiring identification of past hazardous waste disposal sites on DoD installations. The policy was issued in response to the Resource Conservation and Recovery Act (RCRA) of 1976 and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, Public Law (PL) 96-510) of 1980, commonly known as "Superfund." In August 1981, the President delegated certain authority specified under CERCLA to the Secretary of Defense via an Executive Order (EO 12316). As a result of EO 12316, DoD revised the IRP by issuing DEQPPM 81-5 (December 11, 1981), which reissued and amplified all previous directives and memoranda.

Although the DoD IRP and the Environmental Protection Agency (EPA) Superfund programs were essentially the same, differences in the definition of program activities and lines of authority resulted in some confusion between DoD and state/federal regulatory agencies. These difficulties were rectified via passage of the Superfund Amendments and Reauthorization Act (SARA, PL-99-499) of 1986. On January 23, 1987, Presidential Executive Order EO 12580 was issued. EO 12580 effectively revoked EO 12316 and implemented the changes promulgated by SARA.

The most important changes effected by SARA included the following:

- Section 120 of SARA provides that federal facilities, including those in DoD, are subject to all provisions of CERCLA/SARA concerning site assessment, evaluation under the National Contingency Plan [40CFR300], listing on the National Priorities List, and removal/remedial actions. DoD must therefore comply with all the procedural and substantive requirements (guidelines, rules, regulations, and criteria) promulgated by the EPA under Superfund authority.

- Section 211 of SARA also provides continuing statutory authority for DoD to conduct its IRP as part of the Defense Environmental Restoration Program. This was accomplished by adding Chapter 160, Sections 2701-2707 to Title 10 United States Code (10 USC 160).

- SARA also stipulated that terminology used to describe or otherwise identify actions carried out under the IRP shall be substantially the same as the terminology of the regulations and guidelines issued by the EPA under their Superfund authority.

As a result of SARA, the operational activities of the IRP are currently defined and described as follows:

- **Preliminary Assessment**

  The Preliminary Assessment (PA) process consists of personnel interviews and a records search designed to identify and evaluate past disposal and/or spill sites that might pose a potential and/or actual hazard to public health, public welfare, or the environment. Previously undocumented information is obtained through the interviews. The records search focuses on obtaining useful information from aerial photographs; Station plans; facility inventory documents; lists of hazardous materials used at the Station; Station subcontractor reports; Station correspondence; Material Safety Data Sheets; federal/state agency scientific reports and statistics; federal administrative documents; federal/state records on endangered species, threatened species, and critical habitats; documents from local government offices; and numerous standard reference sources.

- **Site Inspection/Remedial Investigation/Feasibility Study**

  The Site Inspection consists of field activities designed to confirm the presence or absence of contamination at the potential sites identified in the PA. An expanded Site Inspection has been designed by the Air National Guard as a Site Investigation. The Site Investigation (SI) will include additional field tests and the installation of monitoring wells to

provide data from which site-specific decisions regarding remediation actions can be made. The activities undertaken during the SI fall into three distinct categories: screening activities, confirmation and delineation activities, and optional activities. Screening activities are conducted to gather preliminary data on each site. Confirmation and delineation activities include specific media sampling and laboratory analysis to confirm either the presence or the absence of contamination, levels of contamination, and the potential for contaminant migration. Optional activities will be used if additional data is needed to reach a decision point for a site. The general approach for the design of the SI activities is to sequence the field activities so that data are acquired and used as the field investigation progresses. This is done in order to determine the absence or presence of contamination in a relatively short period of time, optimize data collection and data quality, and to keep costs to a minimum.

The Remedial Investigation (RI) consists of field activities designed to quantify and identify the potential contaminant, the extent of the contaminant plume, and the pathways of contaminant migration.

If applicable, a public health evaluation is performed to analyze the collected data. Field tests, which may necessitate the installation of monitoring wells or the collection and analysis of water, soil, and/or sediment samples, are required. Careful documentation and quality control procedures in accordance with CERCLA/SARA guidelines ensure the validity of data. Hydrogeologic studies are conducted to determine the underlying strata, groundwater flow rates, and direction of contaminant migration. The findings from these studies result in the selection of one or more of the following options:

1. **No Further Action** - Investigations do not indicate harmful levels of contamination that pose a significant threat to human health or the environment. The site does not warrant further IRP action, and a Decision Document will be prepared to close out the site.

2. **Long-Term Monitoring** - Evaluations do not detect sufficient contamination to justify costly remedial actions. Long-term monitoring may be recommended to detect the possibility of future problems.

3. **Feasibility Study** - Investigation confirms the presence of contamination that may pose a threat to human health and/or the environment, and some sort of remedial action is indicated. The Feasibility Study (FS) is therefore designed and developed to identify and select the most appropriate remedial action. The FS may include individual sites, groups of sites, or all sites on an

installation. Remedial alternatives are chosen according to engineering and cost feasibility, state/federal regulatory requirements, public health effects, and environmental impacts. The end result of the FS is the selection of the most appropriate remedial action with concurrence by state and/or federal regulatory agencies.

- **Remedial Design/Remedial Action**

  The Remedial Design involves formulation and approval of the engineering designs required to implement the selected remedial action. The Remedial Action is the actual implementation of the remedial alternative. It refers to the accomplishment of measures to eliminate the hazard or, at a minimum, reduce it to an acceptable limit. Covering a landfill with an impermeable cap, pumping and treating contaminated groundwater, installing a new water distribution system, and in situ biodegradation of contaminated soils are examples of remedial measures that might be selected. In some cases, after the remedial actions have been completed, a long-term monitoring system may be installed as a precautionary measure to detect any contaminant migration or to document the efficiency of remediation.

- **Research and Development**

  Research and Development (R&D) activities are not always applicable for an IRP site but may be necessary if there is a requirement for additional research and development of control measures. R&D tasks may be initiated for sites that cannot be characterized or controlled through the application of currently available, proven technology. It can also, in some instances, be used for sites deemed suitable for evaluating new technologies.

- **Immediate Action Alternatives**

  At any point, it may be determined that a former waste disposal site poses an immediate threat to public health or the environment, thus necessitating prompt removal of the contaminant. Immediate action, such as limiting access to the site, capping or removing contaminated soils, and/or providing an alternate water supply may suffice as effective control measures. Sites requiring immediate removal action maintain IRP status in order to determine the need for additional remedial planning or long-term monitoring. Removal measures or other appropriate remedial actions may be implemented during any phase of an IRP project.

B. Purpose

The purpose of this IRP PA is to identify and evaluate suspected problems associated with past waste handling procedures, disposal sites, and spill sites on Station property.

The potential for migration of hazardous contaminants was evaluated by visiting the Station, reviewing existing environmental data, analyzing Station records concerning the use of hazardous materials and the generation of hazardous wastes, and conducting interviews with current Station personnel who had knowledge of past waste disposal techniques and handling methods. Pertinent information collected and analyzed as part of the PA included a records search of the history of the Station; the local geological, hydrological, and meteorological conditions that might influence migration of contaminants; and ecological settings that indicate environmentally sensitive conditions.

C. Scope

The scope was limited to the identification of sites at or under primary control of the Station and evaluation of potential receptors. The PA included:

- an on-site visit during the week of May 7-10, 1990;
- acquisition of records and information on hazardous materials use and waste handling practices;
- acquisition of available geological, hydrological, meteorological, land use and zoning, critical habitat, and related data from federal and state agencies;
- a review and analysis of all information obtained; and
- preparation of a summary report to include recommendations for further action.

The subcontractor effort was conducted by the following Science & Technology, Inc. (SciTek) personnel: Mr. Tracy C. Brown, Environmental Analyst; Mr. Charles T. Goodroe, Environmental Protection Specialist; and Mr. Stephen B. Selecman, Geologist/Hydrogeologist. Mr. Michael Minior of the NGB is Project Officer for this Station and participated in the overall assessment during the week of the station visit. Mr. Steven R. Fleming of the Hazardous Waste Remedial Actions Program (HAZWRAP) also participated in the station visit.

The point of contact (POC) at the Station was Lieutenant Colonel Joseph B. Bellino. Major Gordon A. Dushane (104th Civil Engineering Squadron) was the representative from their civil engineering support facility.

D. Methodology

The PA began with a visit to the Station to identify all operations that may have used hazardous materials or may have generated hazardous wastes. Figure I.1 is a flow chart of the PA methodology.

Six present Station employees familiar with the various operating procedures were interviewed. These interviews were conducted to determine those areas where waste materials (hazardous or nonhazardous) were used, spilled, stored, disposed of, or released into the environment. The interviewees' knowledge and experience with Station operations averaged 26 years and ranged from 15 to 33 years.

Records contained in the Station files were collected and reviewed to supplement the information obtained from the interviews.

Detailed geological, hydrological, meteorological, and environmental data for the area were obtained from the appropriate federal, state, and local agencies. A listing of agency contacts is included as Appendix A.

After a detailed analysis of all the information obtained, it was concluded that one site may be potentially contaminated with hazardous wastes. Under the IRP program, when sufficient information is available, sites are numerically scored using the Air Force Hazard Assessment Rating Methodology (HARM). A description of HARM is presented in Appendix B.

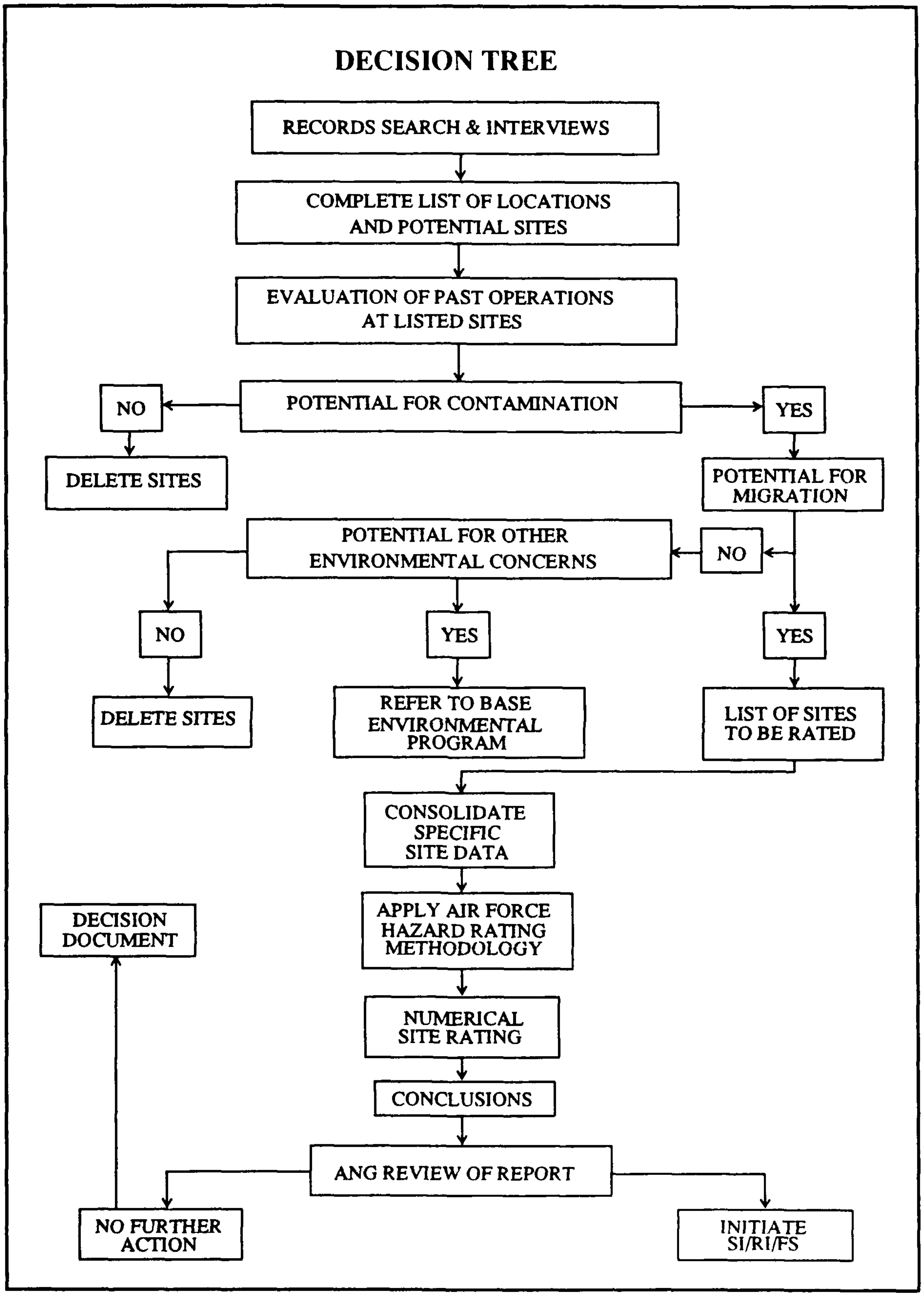


Figure I.1

Preliminary Assessment Methodology Flow Chart

II. INSTALLATION DESCRIPTION

A. Location

The Station is located on the crest of a hill just south of Green Hill Pond on Sky Line Drive north of State Route 9 within the city and county of Worcester, Massachusetts. Elevation of the Station is 785 feet above mean sea level (AMSL). Figure II.1 illustrates the location and boundaries of the Station.

The Station occupies a total of seven acres. Three permanent structures are contained within its boundaries. The main facility (Building 001) houses both the 101st TCS and the 212th EIS units and their respective vehicle maintenance operations. The second facility is the aerospace ground equipment (AGE) (Building 002). The third building (Building 003) is the 212th EIS storage facility.

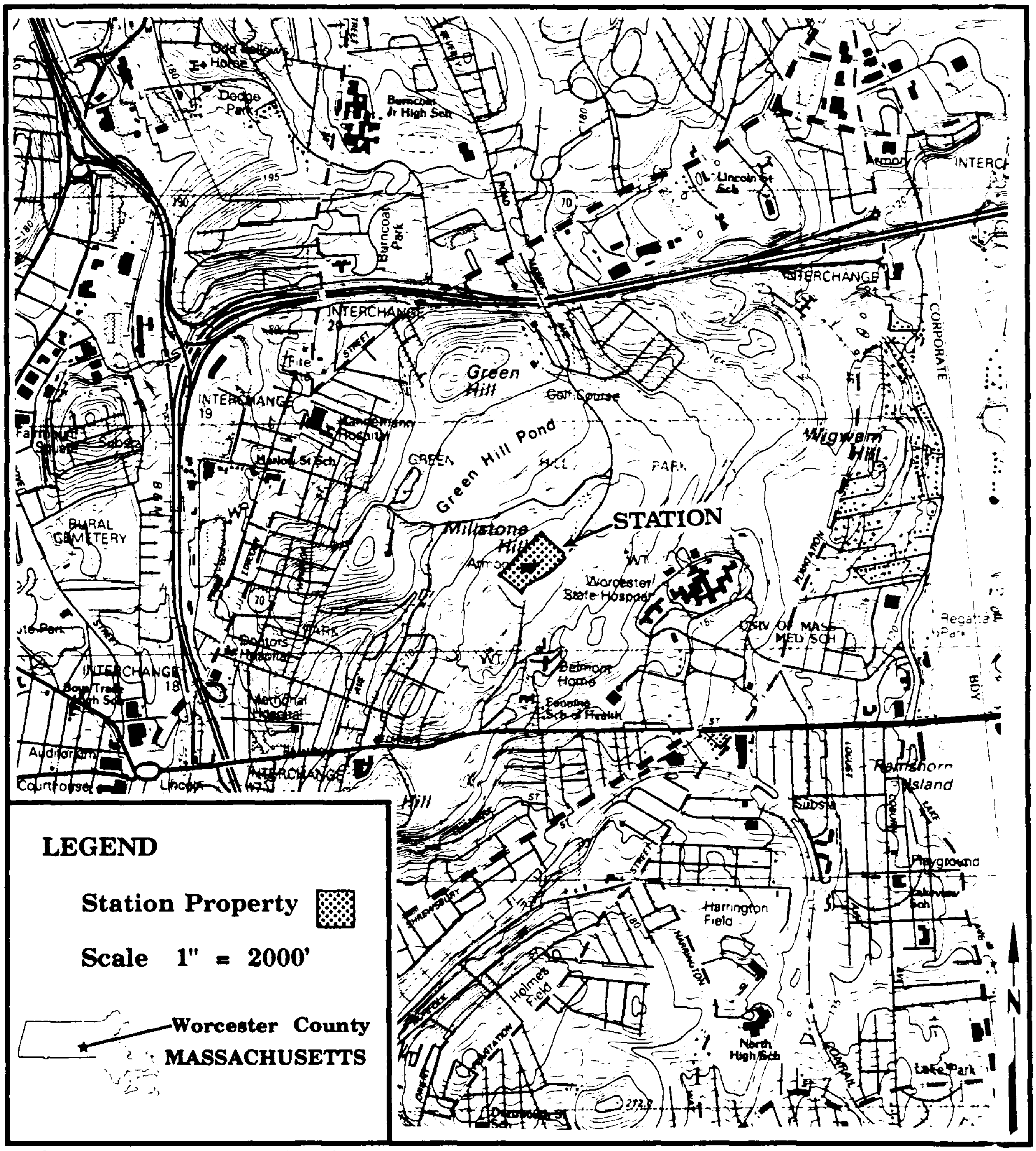
The population of the Station during the week numbers 63 members. Unit Training Assembly occurs one weekend per month. The Station population during this weekend is 433 members.

B. Organization and History

On February 1, 1956, the property was leased for the Worcester ANG Station. The principal building was completed in 1957, and the AGE building was completed in 1982. Prior to the construction of the Station, the property was unimproved. Operations at the Station began in 1957. The Station is occupied by two organizations. The 101st TCS is the host unit located at the Station while the 212th EIS is a tenant unit.

The 101st TCS is the primary generator of waste materials; however, the 212th EIS produces nominal amounts. Both units arrived at the Station in 1957. The 101st TCS moved from Worcester Airport upon completion of the main facility and was originally organized as the 101st Aircraft Control and Warning Squadron. The mission of the 101st TCS is to provide administrative and operational control of a 407L Control and Reporting Post including radar, communications and control facilities, radio relay, and high frequency/single side band, as well as satellite communications in support of Tactical Air Operations. Their mission has not changed significantly over the past 33 years. Mission improvements have been made through advancements in technology.

The 212th EIS was relocated to the Station from the Grove Street Armory in Worcester. They were organized as the 601st Signal Light Construction Company in 1947. The unit has been redesignated several times over the



SOURCE: USGS, Worcester North Quad, 7.5 minute (topographic), 1983.

Figure II.1

Location Map of the Worcester Air National Guard Station

years. The mission of the 212th EIS is to mobilize and deploy authorized resources and supporting assets to accomplish the engineering, installation, reconstruction, and/or replacement of communications-computer systems and tracals. Their mission has not changed significantly except for equipment improvements.

The principal structure is a large one-story building housing the Headquarters and Administrative elements of both units along with their respective motor vehicle service shops. Other structures on the property are the AGE maintenance building of the 101st TCS and a one-story building used by the 212th EIS for storage.

Maintenance functions have always been performed on the property because of the missions of the assigned units. The repair and servicing of motor vehicles and AGE items currently take place on the property. Underground storage tanks (USTs) for heating fuel, diesel oil, jet fuel (JP-4), automotive gasoline (MOGAS), and waste products are on the property. There are two oil/water separators (OWSs) that aid in the prevention of property degradation.

Materials recognized as hazardous have been generated on this property since the establishment of the Station. With the awareness of hazardous materials and the recognition of their impact on the environment, acceptable disposable practices and procedures have evolved. The majority of hazardous wastes are now collected and disposed of through contractors and the Defense Reutilization and Marketing Office (DRMO).

III. ENVIRONMENTAL SETTING

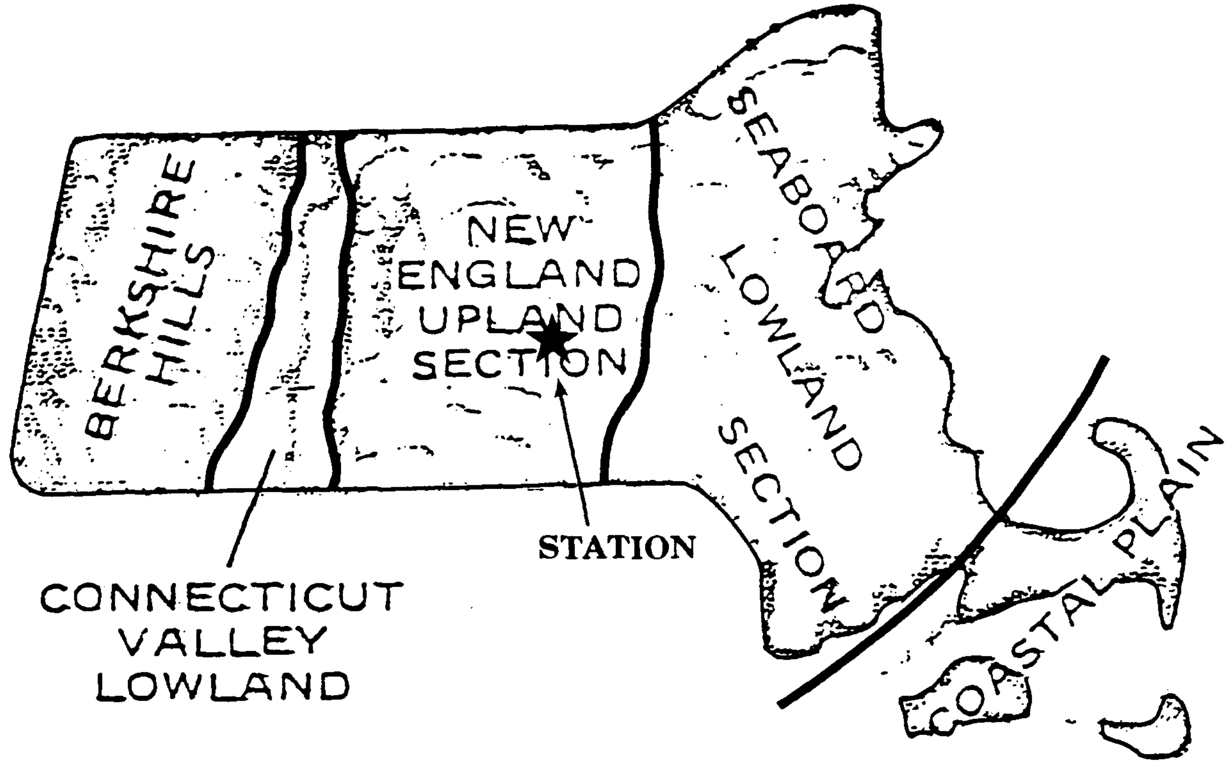
A. Meteorology

The following climatological data is largely derived from the National Climatic Data Center, Asheville, North Carolina, and is published in the Soil Survey of Worcester County, Massachusetts, Northeastern Part (United States Department of Agriculture (USDA): Soil Conservation Service, 1985). Worcester County is characterized by cold winters and moderate summers with occasional hot spells. Precipitation is evenly distributed throughout the year. The total average annual precipitation, based on a 27-year record (1951-1978), is 45.59 inches, and it ranges from an average monthly high of 4.49 inches in November to an average monthly low of 3.36 inches in July. By calculating net precipitation according to the method outlined in the Federal Regulations CERCLA Pollution Contingency Plan (United States Environmental Protection Agency, 55 FR 8813, Subpart K, March 8, 1990), a net precipitation value of 18.59 inches is obtained. The heaviest rainfall during the reporting period was 4.43 inches at Fitchburg on September 12, 1954. The 1-year, 24-hour average rainfall is approximately 2.5 inches. Thunderstorms occur on an average of 21 days a year, mostly in the summer. Normal snowfall totals approximately 65 inches a year, and an average of 22 days a year have at least one inch of snow on the ground. The average annual temperature for the 27-year reporting period was 48.0°F, and the average monthly temperature ranged from 71.9°F in July to 24.0°F in January. Prevailing wind direction is from the west. Average windspeed is highest in the winter of the year at 14 miles per hour.

B. Geology

Massachusetts is divided into the New England and Coastal Plain physiographic provinces. The southeastern peninsula and outer islands of Massachusetts are included in the Coastal Plain province while the remainder of the State exists in the New England province (Figure III.1). The New England province is further subdivided into sections (Fenneman, 1938). The Station is located in the east-central section, termed the New England Upland.

The New England Upland section is characterized by glacial topography with moderate to moderately high relief. Topography has been determined by the distribution and resistance of bedrock in relation to preglacial and glacial erosion. Topographic elevations increase from the eastern river valley lowlands toward the maturely dissected plateau of the west (Stone, 1980). Surface elevations are commonly greater than 500 feet AMSL in the New England Upland section and range from 350 to 780 feet AMSL in the immediate vicinity of the Station. The Station is located in the eastern part of the section along a subdued escarpment which is oriented in a north to south direction (United



LEGEND

Physiographic Sections in the State of Massachusetts

Section Boundaries

N

SOURCE: Frimpter, M. H., Massachusetts Ground-Water Resources, USGS, Water Supply Paper #2275, 1984.

Figure III.1

Physiographic Map of Massachusetts

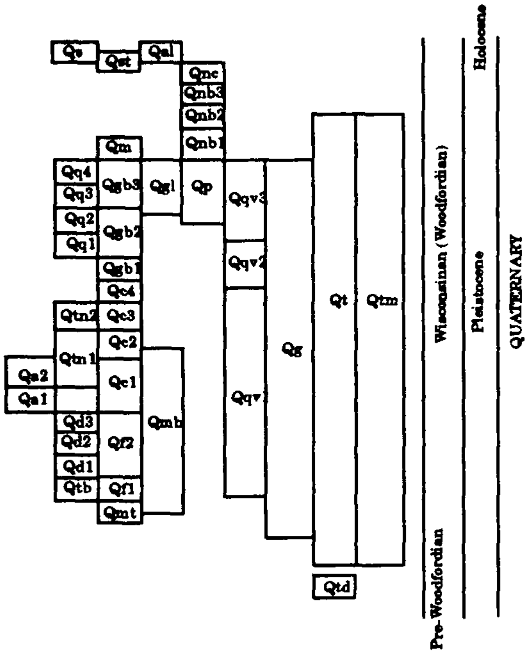
States Department of Agriculture (USDA): Soil Conservation Service, 1985). This escarpment roughly divides the New England Upland section from the Seaboard Lowland section which exists to the east. Specifically, the Station is located on top of a bedrock resistant hill named Millstone Hill, where the surface elevation is approximately 750 to 780 feet AMSL.

The bedrock in the area is, for the most part, covered by a thin layer of surficial material of varying thickness (Walker and Krejmas, 1986). Surface material is primarily composed of Pleistocene glacial deposits and, to a lesser degree, postglacial Holocene deposits. Postglacial material generally consists of stream-terrace, alluvium, and swamp deposits. The postglacial deposits generally occur in topographic lowlands and are very limited in aerial extent due to the upland nature of the area. As a result of the high topographic position of the Station, surface material there is composed only of Pleistocene glacial deposits and the corresponding overlying soils.

Glacial ice moved across the area in a general southerly direction. Preglacial surface deposits and weathered bedrock was removed by the effects of glacial erosion (Stone, 1980). In the wake of glaciation, a thin veneer of glacial drift was deposited in varying thicknesses, covering much of the bedrock. Glacial deposits consist primarily of nonstratified till, stratified glacial-lake deposits, and stratified glacial-stream deposits. Nonstratified till is widespread throughout the area and is exposed in the upland. Stratified glacial deposits are generally younger and exist at lower topographic levels than the nonstratified deposits. This results from the stratified material being deposited by glacial meltwater derived from deglaciation (Nelson, 1974).

Surficial geologic mapping indicates the Station is underlain by nonstratified glacial till. Three basic types of till have been identified in the area (Stone, 1980). They are termed the Drumlin, the Woodfordian, and the Mixed, which is composed of the two previous types. A detailed lithologic description for each is given in Figure III.2. Specifically, the Station is underlain by the noncompact variety of Woodfordian till (Figure III.3), which is composed of a poorly sorted mixture of pebbles, cobbles, and boulders in a fine sand matrix (Stone, 1980). As a result of poor sorting, the till has a very low permeability (Walker and Krejmas, 1986). Deposited over the resistant bedrock at the Station location, the Woodfordian till exists as a thin ground moraine. The thickness of the till is generally less than 3 meters, and total thickness of the surficial material at the Station is projected at substantially less than 3 meters. Bedrock outcrops exist at or very near the surface in the immediate vicinity of the Station (Stone, 1980).

The Drumlin till does not occur at the surface in the general vicinity of the Station. However, the mixed till is mapped as occurring north, west, and southwest from the Station on the adjoining hills (Figure III.3). In addition, deposits of stratified glacial material do not exist in the immediate proximity



DESCRIPTION OF MAP UNITS

Mapped deposits are generally 1 m or more thick. A mantle of yellowish-orange windblown silt and fine sand, commonly mixed with sand and stones of the underlying glacial deposit, irregularly covers many of the mapped deposits; it is not shown where less than 1 m thick.

POSTGLACIAL DEPOSITS

Qal ALLUVIUM (HOLOCENE) - Dark gray to buff sand, silt and pebble-cobble gravel, containing variable amounts of organic material. Texture is highly variable. Alluvium underlying wide parts of the Quinapoxet River flood plain generally fines upward from gravel at the base to fine sand exposed in the flood plain: coarse gravel and sand alluvium underlying narrow flood plain areas is as thick as 3 m and overlies glacial-lake deposits (log HRW-56). Alluvium in tributary valleys is generally sand and locally fine to medium gravel, less than 2 m thick.

Qs SWAMP DEPOSITS (HOLOCENE AND PLEISTOCENE)-Includes muck and peat and minor amounts of sand, silt, and clay. Swamp deposits in valley kettle holes and adjacent to man-made ponds are generally less than 10 m thick. Upland swamp deposits are less than 6 m thick.

Qst STREAM-TERRACE DEPOSITS (HOLOCENE AND PLEISTOCENE - Buff to brown pebble gravel and sand, pebbly coarse sand, or sand and silt. Deposits along Quinapoxet River, as thick as 6 m, overlie glacial-lake deposits (log HRW-61).

GLACIOFLUVIAL DEPOSITS (PLEISTOCENE-WISCONSINAN (WOODFORDIAN)-Sand, gravel, and minor silt, coarse, and fine-textured beds are interlayered in vertical section; sediments were deposited by meltwater streams in successive south to north ice retreatal positions in narrow valleys and are graded to local base levels; upstream parts of each deposit were laid down in contact with stagnant ice, deposits range from cobble boulder gravel in massive, poorly sorted, horizontally layered beds in the ice-contact part of each unit, to crossbedded and horizontally bedded gravel, pebbly sand, and sand having minor fine sand and silt interbeds in downstream part of unit, deposits average 10 m in thickness and are locally as thick as 20 m, contain local kettle-hole sediments of silt, clay, and organic material (logs XSB-n15, XSX-10).

Qgb3 Qgb2 Qgb1 GATES BROOK DEPOSITS-Fluvial lacustrine section as much as 16 m thick under flat delta plain (unit Qgb2), graded to spillway north of Woodland Street

Qtn2 Qtn1 TANNERY BROOK DEPOSITS-Fluvial lacustrine section 10-15 m thick, graded to spillway at Mass Route 31.

Qc4 Qc3 Qc2 Qc1 CHAFFIN POND DEPOSITS-Fluvial-deltaic section 20-25 m thick, locally overlies lake bottom silt and fine sand as much as 12 m thick (HRW-140, UNIT Qc2), graded to spillway at southeast corner of Chaffin Pond

Qa2 Qa1 ASNEBUMSKIT BROOK DEPOSITS-Fluvial-lacustrine section (Qa1) as much as 18 m thick, graded to spillway at south end of Kendall Reservoir; fluvial-lacustrine section (Qa2) as much as 20 m thick, graded to spillway *east of Eagle Lake.*

Qd3 Qd2 Qd1 DAWSON POND DEPOSITS- Fluvial-lacustrine section 12 m thick; graded to local spillways.

Qtb TATNUCK BROOK DEPOSITS-Collapsed coarse fluvial sediments 4 m thick, and local sand and silt pond-bottom sediments, graded to local spillways.

Qf2 Qf1 FARM BROOK DEPOSITS-Collapsed fluvial-lacustrine section (Qf1), locally 20 m thick, graded to local spillways, fluvial-lacustrine section (Qf2), 30 m thick, graded to spillway on northeast side of Winter Hill.

Qt TILL (PLEISTOCENE-WISCONSINAN [WOODFORDIAN])-Two types of till are included in the map unit. The most areally abundant type of till is a noncompact, gray (nonoxidized), poorly sorted mixture of pebbles, cobbles, and boulders in a fine-sand matrix. Irregular lenses of waterlaid sand and gravel are common. The noncompact ill is irregularly distributed in the uplands, locally on top of bedrock and the compact till described below, and generally less than 3 m thick. The second type of till is a compact, gray (nonoxidized), poorly sorted mixture of pebbles, cobbles, and few boulders having fine sand matrix in the uplands and a silty matrix in Beaver Brook and Nashua River lowlands. The till may be locally as much as 6 m thick. The compact till underlies many of the meltwater deposits in the lowlands (logs HRW-58, HRW-61, HRW-140, WSW-25, XSB-007, XSB-118).

Qtm MIXED TILL (PLEISTOCENE-WISCONSINAN [WOODFORDIAN])-Chiefly compact sandy gray Woodfordian till at the surface, 1-2 m thick, containing discrete pebble size angular clasts of olive-brown, oxidized drumlin till (pre-Woodfordian unit Qtd), passing downward into a 1-3 in zone of mixed loose sandy gray till matrix and elongate boulder-size olive-brown and gray (nonoxidized) drumlin till clasts, locally bounded by irregular, thin sand and silt laminae and lenses, locally overlying very large gray and olive drumlin till clasts having few parting laminae and no loose sandy matrix; all or part of mixed till unit overlies thick drumlin till in drumlin cores. Extent of unit shown schematically, inferred from exposures of mixed till and drumlin till, subsurface drilling data and drumlin morphology.

Qtd DRUMLIN TILL (PLEISTOCENE-PRE-WOODFORDIAN)-A very compact mixture of few pebbles and cobbles in a fine silt and clay matrix. At the top, the till is olive brown and has a pervasive iron oxide stain throughout the matrix, a subhorizontal fissility is locally developed. This fissility and a weakly developed subvertical joint system impart an angular blocky structure to the till. Black iron and manganese oxide coatings, and thin clay coatings are common along vertical parting surfaces and occur on some horizontal parting surfaces. The oxidized till grades downward 3-6 in. to nonoxidized, nonfissile, dense dark-gray till. Total thickness of gray, olive-brown, and mixed pre-Woodfordian and Woodfordian till may exceed 20 m in drumlins. Angular clasts of silt, fine sand, and clay in thin and irregular laminae interbedded with thin beds of drumlin till were exposed in a temporary highway cut in drumlin till north of Indian Hill. The clasts are included in an angular breccia, more than 3 m thick, which also includes larger compact clasts of drumlin till in a sheared matrix.

(continued on page III-5)

SOURCE: USGS, Surficial Geologic Map of the Worcester North Quadrangle and Part of the Paxton Quadrangle, 1980.

Figure III.2

Generalized Stratigraphic Column of the Area

(continued from page III-4)

Qp POOR FARM BROOK DEPOSITS-Generally less than 6 m thick, glacial to narrow channel at south end of deposit

Qg GLACIAL MELTWATER DEPOSITS, UNCORRELATED-Includes minor deposits, fluvial and fluvial deltas, not clearly related to major meltwater deposits, graded to local base levels.

Qmb **Qmt** MIDDLE RIVER DEPOSITS-Locally 18 m thick (logs XSX-10, XSX-26) at Rural Cemetery, more than 20 m thick beneath downtown Worcester (logs XSB-n15, XSB-n106) graded to base level at head of Blackstone River in the Worcester South quadrangle.

Qw WADSWORTH BROOK DEPOSITS-Graded to narrow channel under Holden Reservoir No. 2; 10-15 m thick.

Qk KETTLE BROOK DEPOSITS-Average 10 m in thickness

GLACIAL FLUVIAL-LACUSTRINE ICE-CONTACT DEPOSITS (PLEISTOCENE-WISCONSINAN [WOODFORDIAN])-Fluvial, deltaic and lake-bottom deposits in major ice-marginal lakes in the Nashua River and Quinsigamond lowlands. Fluvial beds grade from cobble gravel, as much as 15 m thick (Qnb1), deposited on top of till or bedrock along valley walls to pebble cobble gravel and interbedded sand 1-3 m thick, overlying inclined delta foreset beds. Foreset strata are interbedded pebbly sand, sand, and pebble cobble gravel, 10-15 m thick in upstream parts of deltas, downstream foreset beds are sand and silt. Collapsed fluvial and deltaic beds are as much as 30 m thick in Quinsigamond valley (logs XSB-007, XSB-141). Lake-bottom silt and sand and minor clay, 20 m thick, underlies Qnb1,2 deposits and locally underlies Quinsigamond valley deltaic deposits (logs XSB-118, XSB-133).

GLACIAL LAKE NASHUA DEPOSITS-Deltaic, fluvial, and lake-bottom sediments deposited in or graded to the Boylston (Qnb1-3) Stage or Clinton (Qnc) Stage of glacial Lake Nashua. the bedrock-floored saddle just below 450 ft. (137 m) elevation at the south end or Wachusett Reservoir was the spillway for the Boylston Stage. A bedrock spillway at 350 ft. (107 m) elevation at Rattlesnake Hill. Clinton quadrangle controlled the level of the Clinton Stage (Koteff, 1966).

Qnc Clinton Stage Deposits-Chiefly fluvial sediments less than 5 m thick. Deposits overlie older Boylston Stage lake bottom and collapsed deltaic sediments

Qnb3 **Qnb2** **Qnb1** Boylston Stage Deposits-Fluvial-lacustrine section 30-40 m thick fluvial sediments (Qnb1) as much as 15 m thick beneath West Boylston village, locally collapsed fluvial and deltaic beds as much as 30 m thick (log WSW-25).

Qqv3 **Qqv2** **Qqv1** Quinsigamond Valley Deposits-Coarse-grained fluvial lacustrine section generally 20-30 m thick (logs XSB-141, XSB-007), locally as much as 30 m thick (logs XSB-118, XSB-133) graded to interconnected ice-marginal ponds controlled by spillway to Grafton quadrangle.

GLACIAL LACUSTRINE ICE-CONTACT DEPSOTIS (PLEISTOCENE-WISCONSINAN [WOODFORDIAN])-Sand, gravel, and minor silt in overall coarsening upward vertical sections, fluvial and deltaic sediments graded to or deposited in contact with stagnant ice, horizontally layered pebble-cobble to cobble gravel and interbedded sand in fluvial topset beds, commonly 4 m thick, overlying inclined delta foreset beds composed of sand, pebbly sand, and pebble gravel, and silt, 5-15 m thick. Coarse-grained topset and foreset beds are intermixed in collapse faults and folds along ice-contact margins of each deposit. Delta bottom set beds and lake-bottom beds, thinly laminated silt and very fine sand, locally more than 10 m thick, underlie deltaic deposits (units Qc2,3, log HRW-140; Qf1,2, log HRW-69; Qd2 and Qtn1,2). Correlation of deposits between depositional basins is tentative.

Qm MALDEN BROOK DEPOSITS-Fluvial-lacustrine, as much as 22 m thick, graded to local spillways cut in till

Qgl LOWER GATES BROOK DEPOSITS-Fluvial-lacustrine section 10-14 m thick, graded to spillway at Summit

Qq4 **Qq3** **Qq2** **Qq1** QUINAPOXET RIVER DEPOSITS-Fluvial-lacustrine section as much as 33 m thick, graded to spillway southwest of Malden Hill

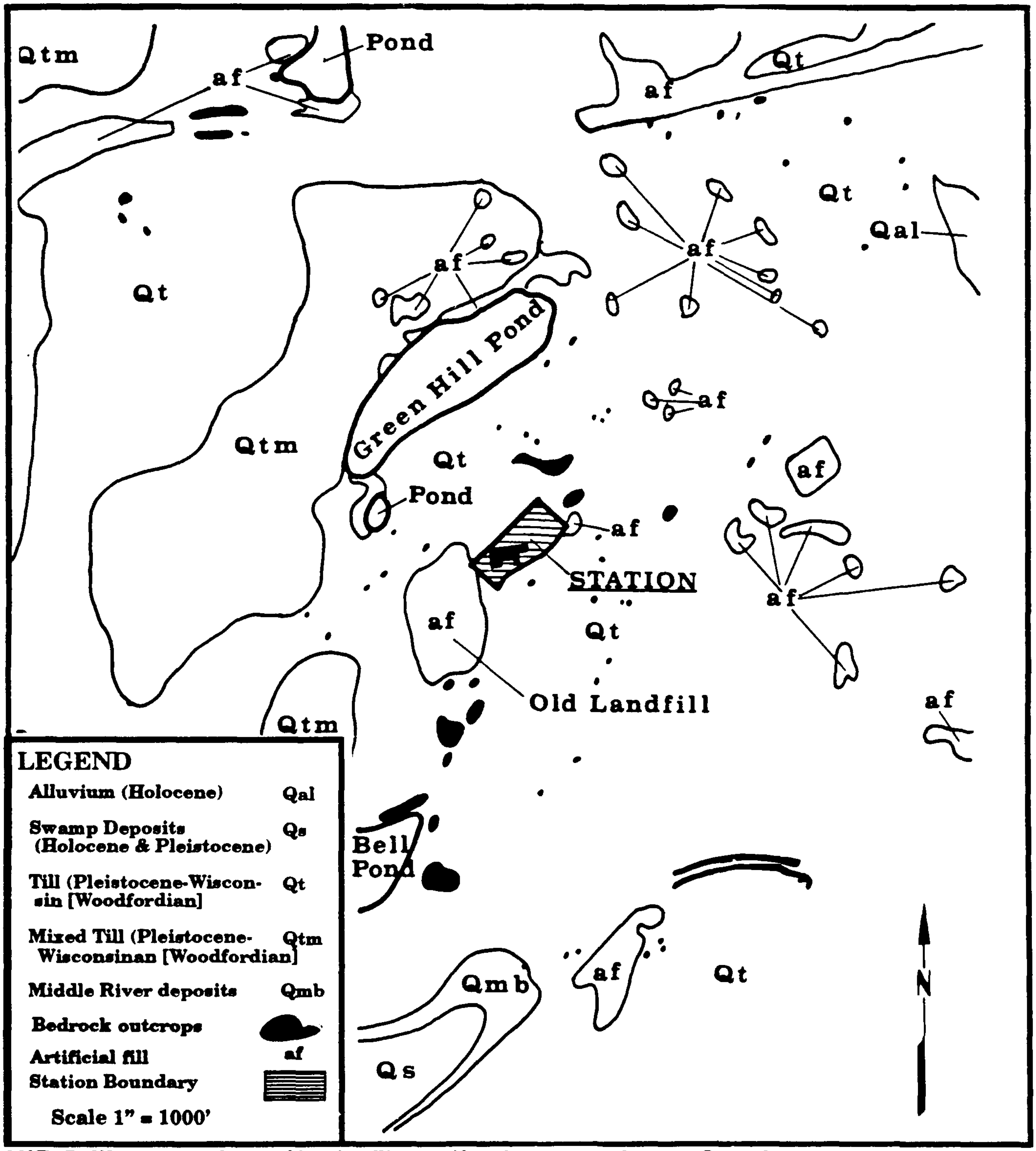
af ARTIFICIAL FILL-Compacted fill excavated from meltwater deposits sandy and compact fill. fill under highways, railroads, buildings, and earthdams is commonly compacted to optimum moisture content Ruled pattern indicates areas of extensive artificial fill, 3-6 m thick, overlying mapped surficial deposit or areas of major excavations and man-made changes of topography.

SHALLOW BEDROCK AND BEDROCK OUTCROPS-Ruled pattern indicates areas where surficial deposits are generally less than 3 m thick locally containing numerous bedrock outcrops, inferred from outcrop pattern, aerial photography interpretation, and subsurface data, solid areas represent continuous outcrop (data in uplands from Hepburn, 1976a).

SOURCE: USGS, Surficial Geologic Map of the Worcester North Quadrangle and Part of the Paxton Quadrangle, 1980.

Figure III.2 (continued)

Generalized Stratigraphic Column of the Area



SOURCE: USGS, Surficial Geologic Map of the Worcester North Quadrangle and Part of the Paxton Quadrangle, 1980.

Figure III.3

Surficial Geologic Map of the Area

of the Station. Deposits of stratified glacial material exist in the topographic lowlands located west, south, and east from the Station. The distance of these deposits in relation to the Station is approximately 0.85, 0.66, and 0.90 miles, respectively.

The bedrock underlying the Station is mapped by Emerson, 1917, as being the Lower Cambrian age Ayer Granite. The Ayer Granite was quarried on Millstone Hill immediately west of the Station. Where it was quarried, Emerson, 1917, described the rock as a light colored, coarse-grained, muscovite-biotite granite, containing some blue quartz. The Ayer Granite has since been named the Ayer Intrusion Complex which consists of several members. Mapping by Barosh in 1977 indicates the Station is underlain by the Millstone Hill Granite member. It is described as a very light to light gray, medium-grained, equigranular, nonfoliated granite to granodiorite that weathers light buff to rusty on outcrop. The structural grain of the bedrock in the area is to the northeast, and the dominant structural features are thrust faults and perpendicular normal faults. Several thrust faults are mapped as occurring in the immediate vicinity of the Station. The large amount of faulting probably has fractured the bedrock to a significant degree at the Station location. In his examination of the Ayer Granite on Millstone Hill, Emerson, 1917, reported observing master vertical joints and minor irregular sets of joints that suggested significant fracturing of the bedrock. Fracturing is important in that it creates secondary porosity and permeability in the bedrock which is otherwise nonpermeable.

The soil overlying the glacial till at the Station location is classified as the Chatfield-Hollis-Rock outcrop complex. This soil type is formed in association with glacial till and is characteristic of hills and ridges with many bedrock exposures. The soil unit is irregular in shape and averages approximately 20 acres in area extent. The complex is composed of moderately deep Chatfield soils (45%), shallow Hollis soils (25%), Rock outcrop (15%), and other soils (15%). The soils are so intermingled that they cannot be mapped separately. Chatfield soils consist of a fine sandy loam, and the depth to bedrock ranges from 20 to 40 inches. Hollis soils are also composed of a fine sandy loam, but the lower 5 inches of subsoil are a gravelly fine sandy loam. Depth to bedrock ranges from 10 to 20 inches for the Hollis soils. The Chatfield and Hollis soils are considered to be well-drained to somewhat excessively drained soils. Permeability is classified as moderate (0.63 to 2.00 inches per hour or 4.45×10^{-4} to 1.41×10^{-3} cm/sec) or moderately rapid (2.00 to 6.00 inches per hour or 1.41×10^{-3} to 4.24×10^{-3} cm/sec). The information pertaining to soils contained in the text was derived from Soil Survey of Worcester County, Massachusetts, Northwestern Part (United States Department of Agriculture (USDA): Soil Conservation Service, December, 1985).

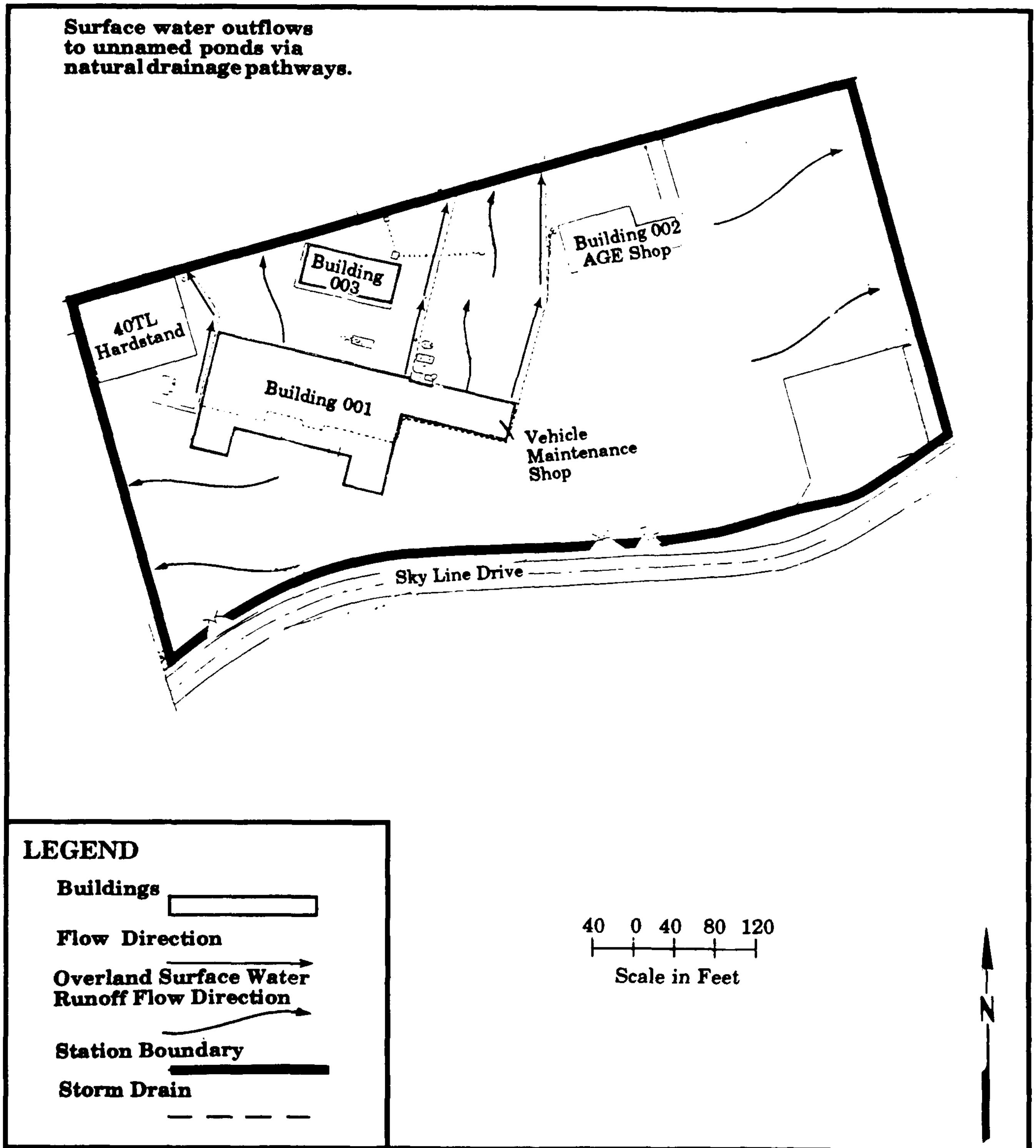
C. Hydrology

1. Surface Water

Surface water on the Station property drains overland, and the drainage can be divided into two basic units. Roughly, the northeast one-third of the Station property drains northeast while the southwest two-thirds drains north and northwest (Figure III.4). Surface water in the northeast one-third flows overland to the northeast and exits the Station property along the northeastern boundary. From this point, surface water flows north along natural drainage pathways down the slope of Millstone Hill. Before reaching the Green Hill Parkway, the flow direction turns west. At this point, some of the surface water appears to empty into a small, unnamed waterfowl pond at the Green Hill Farm and Education Area. The remainder of the surface flow then meanders in a westerly direction along the Parkway before reaching another small pond located near the intersection of the Parkway and Rodney Street (Figure III.5). The distance along this drainage pathway from the northeast property boundary to the pond located at the junction of the Parkway and Rodney Street is approximately 2000 feet (Moore Survey and Mapping Corp., 1975).

In the southwestern two-thirds of the Station, surface water drains overland to the north and northwest (Figure III.4) Surface water exits the Station property along the northwestern boundary where it flows in a general north/northwesterly direction down Millstone Hill along natural drainage pathways. Before reaching the Green Hill Parkway, the flow direction becomes westerly where it joins the surface water flow from the northeast in route to the pond located near the intersection of Rodney Street and the Parkway (Figure III.5). The distance of overland flow from the northwest boundary of the Station to the pond along this route is approximately 1250 feet (Moore Survey and Mapping Corp., 1975). All surface water from the Station outflows overland except water that is collected from the roof of the main building. Water from the building roof is transported underground where it exits along the northwestern boundary (Figure III.4) and then follows the flow route described for the southwestern two-thirds of the Station.

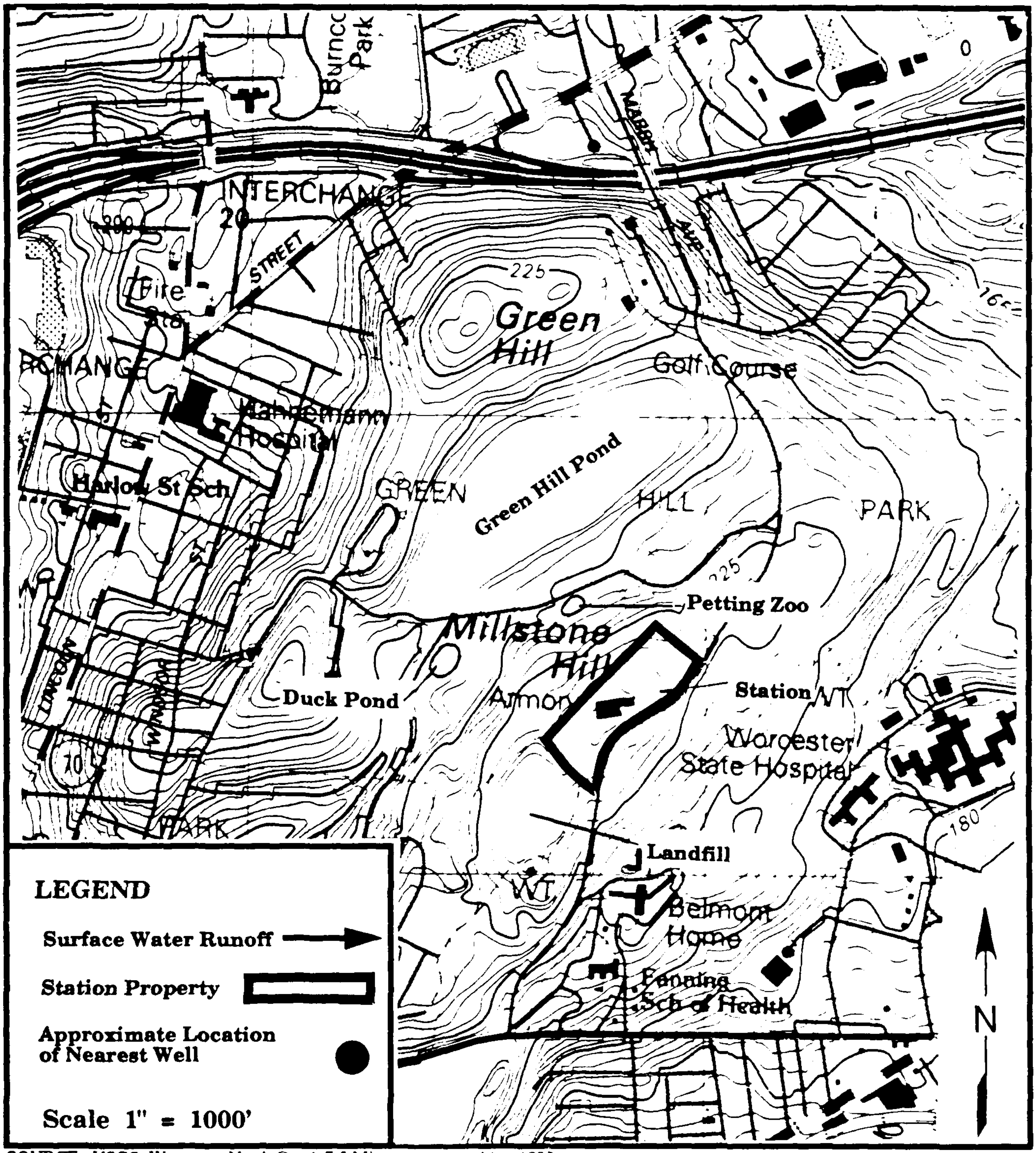
Once a major portion of the surface water reaches the pond located near the intersection of Rodney Street and the Green Hill Parkway, its destination is unknown. The pond is drained by the city of Worcester storm drainage system, but the records for that section of the storm sewer system are incomplete. Furthermore, a visual inspection of the system was inconclusive. As a result of the natural occurrence of the drainage pathways, it is likely that much of the surface water is absorbed by the soil and surface material before reaching the pond. Visual inspection did confirm surface water flow to the pond during periods of heavier rainfall.



SOURCE: Worcester ANG Station, Worcester, Massachusetts, ANG Development Plan, 1989.

Figure III.4

Drainage Map of the Worcester Air National Guard Station



SOURCE: USGS, Worcester North Quad, 7.5 Minute (topographic), 1983.

Figure III.5

Surface Water Flow Route Map

2. Groundwater

The principal aquifers of the Blackstone River Basin are the sand and gravel deposits of glacial origin and the underlying bedrock (Walker and Krejmas, 1986). The glacial sand and gravel aquifer is of primary importance because it is capable of yielding large volumes of water necessary for public use. Bedrock is of secondary consideration because it characteristically yields small volumes of water generally not suitable for public demand. However, bedrock is an important aquifer as it is a major domestic source of water in rural areas and is in some cases used as public supply. The bedrock is the only principal aquifer present at the Station location.

The glacial sand and gravel aquifer primarily occurs as stratified glacial drift deposited by water derived from melting glaciers (Walker et al, 1975). The occurrence of the stratified glacial deposits are generally limited to topographic lowlands and valleys (Walker and Krejmas, 1986). The yield capability of the sand and gravel aquifer is determined by its thickness, particle size, and degree of particle sorting or stratification. Well-sorted, coarse-grained deposits of a thicker nature generally produce the highest yields of water.

Two general types of stratified glacial aquifers have been identified by Walker and Krejmas, 1986. The first type is composed of fine-grained sand, silt, and clay deposited in valleys by temporary lakes of glacial meltwater origin. The second type is composed of medium- to coarse-grained sand, or sand and gravel, derived from glacial meltwater streams. The coarse-grained deposits are found in the principal aquifer and in the public groundwater supply in the basin. Water yields from pumping wells in this aquifer range from a few hundred gallons per minute (GPM) to an excess of 1000 GPM. This is in contrast to yields of 5 to 50 GPM from the fine-grained sand aquifer (Walker and Krejmas, 1986).

High yields from the coarse-grained aquifer are usually associated with induced recharge of the aquifer from surface bodies of water. Normal recharge of stratified glacial aquifers occurs locally by precipitation. Where a body of surface water is located in close proximity to the aquifer, recharge of that aquifer is enhanced through induced infiltration (Walker and Krejmas, 1986). The stratified glacial aquifer is generally an unconfined aquifer; however, it can exist under confined or artesian conditions (Walker and Krejmas, 1986). Depending on where the aquifer exists in relation to surface water, the water table can occur from a few feet to very near the land surface. Groundwater movement is generally perpendicular to surface elevation contours and toward topographic lowlands and surface bodies of water.

The stratified glacial aquifer does not exist at the Station location or in the immediate vicinity. Its nearest occurrence with respect to the Station is in

the topographic lowlands located to the west, south, and east. The nearest occurrence is approximately 0.66 miles to the south of the Station.

The bedrock underlying the area is composed of basically nonporous and nonpermeable consolidated rock. Consequently, it is dependent on secondary fracturing to function as an aquifer (Walker and Krejmas, 1986). As a result of the extensive structural deformation of the area, fracturing of the bedrock is widespread; therefore, the bedrock will yield some amount of water at almost any location. The amount of yield is directly dependent on the size and amount of water-bearing fractures that exist at a given location. Predicting the amount of fracturing occurring in an area is very difficult. Wells might penetrate enough water-bearing fractures 50 feet below the water table for a satisfactory yield at one location while at another location a well might penetrate several hundred feet without intersecting any water-bearing fractures (Walker and Krejmas, 1986). Generally, bedrock wells located in topographic lowlands will have higher yields than wells situated in upland areas. This is likely attributed to added recharge from upland areas and the overlying groundwater stored in the stratified glacial aquifer in the lowland areas (Walker and Krejmas, 1986). The yield capacity of the bedrock aquifer varies greatly because of the irregular distribution and size of the water-bearing fractures. Walker and Krejmas, 1986, report a yield range of 0.2 to 125 GPM, with an average yield of 10 GPM for bedrock wells.

Groundwater within the bedrock aquifer is unconfined within the limits of the fracture system, but occasionally artesian conditions do exist. General groundwater movement can be determined locally by the topography. Groundwater movement is interpreted as occurring perpendicular to surface elevation contours. Due to the high topographic position of the Station, general groundwater movement likely occurs down gradient to the northwest and southeast from the Station. The depth to the water table at this location is estimated at 30 to 50 feet below the land surface.

Available records from the city of Worcester indicate the nearest active well in relation to the Station exists approximately 0.5 miles south at the base of Millstone Hill. A reported yield of 3 GPM was documented in April 1983. The well is used for domestic supply and is screened in the granite bedrock at a depth of 375 to 440 feet below the land surface.

The susceptibility of groundwater to contamination from the Station is considered to be a moderate risk. This is inferred because the major aquifer does not exist at the Station location. Furthermore, the stratified glacial aquifer does not occur in close proximity to the Station or in the pathway of surface water runoff from the Station. The soil and glacial till underlying the Station is thin and nonpermeable. The bedrock is a consolidated, non-permeable material that primarily serves as a low yield aquifer only where sufficient fracturing occurs. Based on the extensive structural deformation that

has occurred in the area and the fracturing observed by Emerson, 1917, in the bedrock at the adjacent quarry, it is likely that significant fracturing does exist. However, available information indicates that the bedrock is not developed extensively as a domestic water source in the immediate vicinity of the Station. In addition, the depth to the water table at the Station location is considered quite deep.

D. Critical Habitats/Endangered or Threatened Species

According to the Environmental Planning Coordinator for the city of Worcester, no endangered or threatened species of flora or fauna have been identified within a 1-mile radius of the Station. There are also no formally designated critical habitats. However, there are four small wetlands within this area. The two closest to the Station are the Bell Pond Wetland System and Green Hill Pond. The Bell Pond Wetland System is located approximately 800 feet southeast of the Station, and Green Hill Pond is located approximately 1200 feet northwest of the Station. Given the presence of these and other small wetlands, a Factor Rating of 2 is used for calculating a Hazard Assessment Score (HAS).

IV. SITE EVALUATION

A. Activity Review

A review of Station records and interviews with personnel were used to identify specific operations in which the majority of hazardous materials and/or hazardous wastes are used, stored, processed, and disposed of. Table IV.1 provides a history of waste generation and disposal for operations conducted by shops at the Station. If an item is not listed on the table on a best-estimated basis, that activity or operation produces negligible (less than 1 gallon/year) waste requiring disposal.

The potable water supply and sanitary sewer service for the Station is provided by the city of Worcester. Potable water is supplied by the Department of Public Works, Water Operations, and the sewage is treated at the Upper Blackstone Valley Regional Treatment Plant in Worcester. There are no water wells at the Station.

B. Disposal/Spill Site Information, Evaluation, and Hazard Assessment

Six persons were interviewed to identify and locate potential sites that may have been contaminated by hazardous wastes as a result of past Station operations. One potentially contaminated site was identified through the interviews. This identification was followed by a visual field examination of the site.

The site was rated by application of the United States Air Force (USAF) HARM (Appendix B), and since the potential for contaminant migration exists at this site, it is recommended for further investigation under the IRP program. Copies of completed HARM forms and an explanation of the factor rating criteria used for site scoring are contained in Appendix C.

Contaminants that may have been released at this site have the potential to be transported by groundwater and surface water; therefore, the potential for contaminant migration does exist at the rated site. The seasonal high water table, which is 30 to 50 feet below the ground surface, has the potential for contamination, depending on the amount of fracturing occurring in the bedrock. Should the bedrock prove to be impermeable, released contaminants have the potential to migrate downslope through the soil substrate. The highest risk of contaminant migration is thought to occur through the downslope movement of surface water containing contaminants exposed at the ground surface. Surface water drainage from the vicinity of the rated site flows primarily to the northwest in the direction of the waterfowl pond at the Green Hill Farm and Education Area and to the small pond at the street intersection immediately southeast of Green Hill Pond.

Table IV.1 Hazardous Materials/Hazardous Wastes Disposal Summary: Worcester Air National Guard Station, Worcester, Massachusetts.

Shop Name and Location	Possible Hazardous Wastes	Estimated Quantities (Gallons/Year)	Method of Disposal (1957 – 1970 – 1980 – 1990)
Vehicle Maintenance (Bldg. 001)	Engine Oil	400	UNK | GRND/PU | GRND/CONTR | DRMO
	Battery Acid	50	UNK | DIL/STORM/OWS | DRMO
	Ethylene Glycol	30	UNK | STORM | DRMO
	Hydraulic Oil	25	UNK | GRND/PU | GRND/CONTR | DRMO
	Transmission Oil	1	UNK | GRND/PU | GRND/CONTR | DRMO
	Xylene	25	UNK | GRND/PU | GRND/CONTR | DRMO
	Brake Fluid	5	UNK | GRND/PU | GRND/CONTR | DRMO
	Diesel Fuel	25	UNK | GRND/PU | GRND/CONTR | DRMO
	Bearing Grease	12 Lbs	UNK | RAGS/TRASH | DRMO
	Parts Cleaner	60	UNK | STORM/OWS | CONTR
	Paint	1	UNK | TRASH

KEY:

CONTR - Disposed of through a contractor.
DIL - Diluted with water.
DRMO - Disposed of through the Defense Reutilization & Marketing Office. (Prior to 1986, this office was known as the Defense Property Disposal Office (DPDO).)
GRND - Material was disposed on ground for weed control.
NIU - Material was not in use at this time.
NLU - Material no longer used.
OWS - Material went to an oil/water separator.
PROC - Material used up in process.
PU - Material was picked up by individuals for personal use.
RAGS - Material wiped onto rags.
STORM - Disposed of through the storm sewer.
TRASH - Disposed of in trash that goes to city landfill.
UNK - Disposal method is unknown.

Table IV.1 Hazardous Materials/Hazardous Wastes Disposal Summary: Worcester Air National Guard Station, Worcester, Massachusetts (continued).

Shop Name and Location	Possible Hazardous Wastes	Estimated Quantities (Gallons/Year)	Method of Disposal 1957 — 1970 — 1980 — 1990
Aerospace Ground Equipment (AGE) Maintenance (Bldg. 002)	Engine Oil	500	UNK | CONTR | DRMO
	JP-4	100	UNK | CONTR | NLU
	JP-5	100	NIU | CONTR | DRMO
	PD-680	10	UNK | CONTR | DRMO
	Parts Cleaner	45	UNK | NIU | CONTR
	7808 Oil	180	UNK | CONTR | DRMO
	Battery Acid	1	NIU | DRMO
	Gunk Degreaser	5	UNK | GRND | NLU

KEY:

CONTR - Disposed of through a contractor.
DIL - Diluted with water.
DRMO - Disposed of through the Defense Reutilization & Marketing Office. (Prior to 1986, this office was known as the Defense Property Disposal Office (DPDO).)
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PU - Material was picked up by individuals for personal use.
RAGS - Material wiped onto rags.
STORM - Disposed of through the storm sewer.
TRASH - Disposed of in trash that goes to city landfill.
UNK - Disposal method is unknown.

The location of the rated site is provided on Figure IV.1. A description of the potential site identified at the Station follows.

Old Embankment/Vicinity of Old Waste Oil Holding Area (HAS-71)

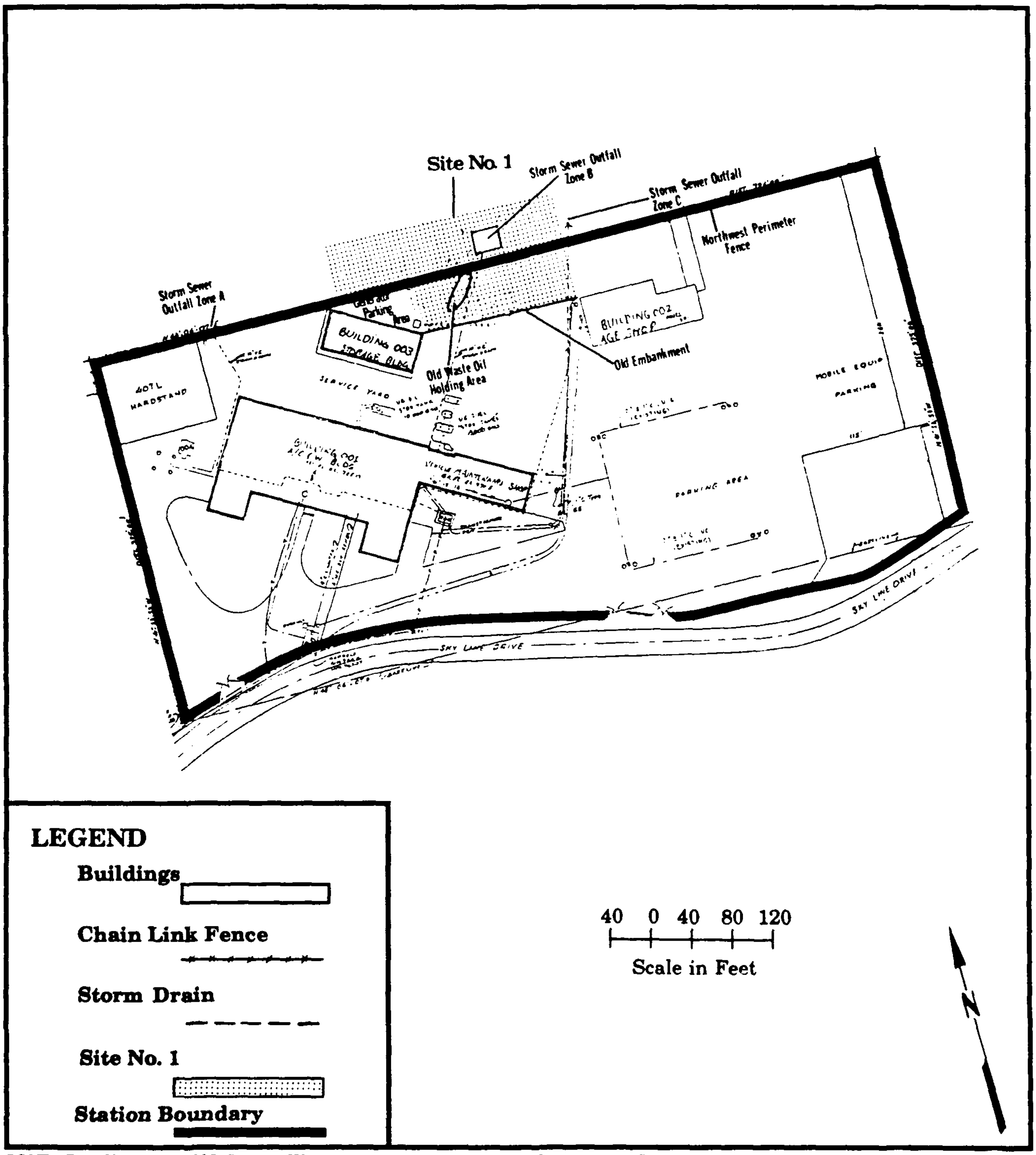
This potentially contaminated site, which was the focus of four different waste handling and disposal activities, is bounded by the southwest corner of Building 002 (AGE Shop), the northeast corner of Building 003 (Storage Building), and an imaginary line drawn parallel to the Northwest Perimeter Fence and located about 30 feet outside of the fence. The site extends onto the area at the base of the current embankment that parallels the fence (Figure IV.1). An arm of the site also extends to the southeast to include an additional portion of the current embankment and the area at its base. The whole site essentially straddles the route of the storm sewer pipe that extends from Building 001 (Vehicle Maintenance Shop) to the Northwest Perimeter Fence.

From an unknown point in time until 1981, the Old Embankment extended from the southwest corner of Building 002 to the northeast corner of Building 003. One interviewee distinctly recalled the use of waste oil, organic solvents, and fuel to kill weeds along this embankment. Approximately 20 to 30 gallons of these wastes were poured along the embankment each year from at least as early as 1969 until the adjacent low area was filled to the current fence line and soil surface in the 1970s. This practice was in effect when the interviewee arrived at the Station in 1969; therefore, the practice may have substantially predated 1969.

From 1975 until about 1981, waste oil, PD-680, xylene, JP-4, JP-5, and diesel fuel from the AGE Shop and the Vehicle Maintenance Shop were temporarily stored in the Old Waste Oil Holding Area located adjacent to the Northwest Perimeter Fence in the east portion of the site. The drums rested on pavement in an area adjacent to an old paving limit. Lids were sometimes left off of the drums, and the contents flowed onto nearby areas of exposed soil. There are no available estimates of spill quantities for this portion of the site.

Mobile generators are kept in the Generator Parking Area along the fence in the southwest portion of the site. These generators have used JP-4 and JP-5. After the area was paved, many small fuel spills (1 gallon or less) and about five spills of approximately 30 gallons each occurred between 1975 and 1988. During this period, one gallon cans were used to collect fuel that normally drained from the generators. Cans containing fuel and precipitation were emptied across the fence line. The total quantity of fuel spilled within the site boundaries remains unknown.

According to interviewees, in 1981 a contractor was erecting new electric utility poles just inside the Northwest Perimeter Fence, and a strong petroleum odor emanated from one auger hole within the site boundaries.



SOURCE: Worcester ANG Station, Worcester, Massachusetts, ANG Development Plan, 1989.

Figure IV.1

Potential Sites

at the Worcester Air National Guard Station

Storm Sewer Outfall Zone B is located 10 feet outside of the Northwest Perimeter Fence. It lies approximately 100 feet northwest of the northeast corner of Building 003 and parallels the base of the embankment outside the fence line. The OWS at Building 001 is tied into a storm sewer line that outfalls at this location. Storm Sewer Outfall Zone B is a moist, rock-laden area of soil measuring approximately 15 feet square. Prior to 1979, waste oil from the Vehicle Maintenance Shop was sometimes poured directly into the floor drain inlet on the assumption that it would be captured by the OWS. The waste oil holding compartment of the OWS has rarely been checked or pumped out since its installation in 1959. Consequently, it is believed that overflowing oil in unknown quantities has been transported to Storm Sewer Outfall Zone B throughout much of the OWS's operational life. A visual examination of this area revealed a slight oil sheen on standing water and some evidence of fading petroleum product stains.

Interviewees provided conflicting information on the Storm Sewer Outfall Zone B. Some had never observed oil in this area and were unaware of past problems with the OWS. However, others had observed oil in the zone and were aware of problems with the OWS. For example, in 1977-1978, one interviewee observed a black substance, assumed to have been waste oil, coating the rocks in the zone. Stressed vegetation was also evident in this area. Civil Engineering at the Barnes Air National Guard Base rectified the overflow problem shortly thereafter, and the interviewee observed no further problems in the zone. However, the OWS holding compartment has been checked irregularly during the 1980s. It was checked in the early 1980s, and oil and sludge were last cleaned from the holding compartment in 1989.

The total quantity of liquid wastes released at this potential site is unknown. Since there is a potential for soil contamination and possibly groundwater contamination from the release of these wastes, a HAS was calculated. For calculation purposes, a small quantity (1100 gallons or less) of liquid wastes is assumed to have been released at this potential site.

C. Other Pertinent Facts

- The Skyline Drive Landfill is located near the southwest end of the Station (Figure III.3). Operations at this municipal facility began around 1968 or 1969 and ended in 1971 or 1972. An old rock quarry is a major component of the landfill site.

- Trash and Nonhazardous solid wastes are disposed of by Waste Management of Central Massachusetts, Inc.

- A National Pollutant Discharge Elimination System (NPDES) Permit is not required at the Station.

- The Station has neither a Spill Prevention, Control, and Countermeasures Plan nor a Spill Prevention and Response Plan. These plans are not required at the Station. However, personnel at the Station are trained to respond in emergency situations, and there is an Emergency Action Checklist for responding to fuel spills. Through a letter of understanding with the city of Worcester, the local Fire Department and Police Department may provide the Station with assistance during an emergency.

- Much of the land surface on the northeast and northwest sides of the Station was created by filling and grading during the early 1980s. Some of the fill consists of waste construction materials such as brick brought in from off-site. There is no evidence that hazardous materials were ever included in the fill material.

- There are two OWSs at the Station. The OWS at the Vehicle Maintenance Shop was installed in 1959 and is connected to the storm sewer system. The OWS at the AGE Shop was installed in 1981 and is connected to the sanitary sewer system.

- No leaking or abandoned USTs were identified at the Station.

V. CONCLUSIONS

Information obtained through interviews with Station personnel, reviews of records, and field observations was used to identify possible spill or disposal sites on the Station property. One potentially contaminated site was identified.

The following site exhibits the potential for contaminant migration through surface water, soil, and/or shallow groundwater:

Site No. 1 - Old Embankment/Vicinity of the Old Waste Oil Holding Area
(HAS - 71)

VI. RECOMMENDATIONS

The PA identified one potentially contaminated site. As a result, additional work under the IRP is recommended for this site to confirm the presence/absence of contamination.

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GLOSSARY OF TERMS

ALLUVIAL - Pertaining to or composed of alluvium, or deposited by a stream of running water.

ALLUVIUM - A general term for detrital deposits made by streams on river beds, flood plains, and alluvial fans. The term applies to stream deposits of recent time.

ANNUAL PRECIPITATION - The total amount of rainfall and snowfall for the year.

ANTICLINE - A fold, generally convex upward, whose core contains the stratigraphically older rocks.

AQUICLUDES - A body of rock that will absorb water slowly but will not transmit it fast enough to supply a well or spring.

AQUIFER - A body of rock that is sufficiently permeable to conduct groundwater and yield economically significant quantities of water to wells and springs.

ARGILLACEOUS - Like or containing clay.

ARTESIAN AQUIFER - A water-bearing bed that contains water under hydrostatic pressure.

BASALT - A dark colored igneous rock, commonly extrusive, composed primarily of calcic plagioclase and pyroxene; the fine grained equivalent of gabbro.

BASIN - (a) A depressed area with no surface outlet; (b) A drainage basin or river basin; (c) A low area in the Earth's crust, of tectonic origin, in which sediments have accumulated.

BAY - A wide, curving open indentation, recess, or inlet of a sea or lake into the land or between two capes or headlands, larger than a cove, and usually smaller than, but of the same general character as a gulf.

BED [stratig] - The smallest formal unit in the hierarchy of lithostratigraphic units. In a stratified sequence of rocks, it is distinguishable from layers above and below. A bed commonly ranges in thickness from a centimeter to a few meters.

BEDDING [stratig] - The arrangement of sedimentary rock in beds or layers of varying thickness and character.

BEDROCK - A general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.

BOULDER - A detached rock mass larger than a cobble, having a diameter greater than 256 mm, being somewhat rounded or otherwise distinctly shaped by abrasion in the course of transport.

CALCAREOUS - Containing calcium carbonate.

CLAY [geol] - A rock or mineral fragment or a detrital particle of any composition smaller than a fine silt grain, having a diameter less than 1/256 mm (4 microns).

CLAY [soil] - A rock or mineral particle in the soil having a diameter less than 0.002 mm (2 microns).

COARSE-GRAINED - 1. Said of a crystalline rock, and of its texture, in which the individual minerals are relatively large, e.g. an igneous rock whose particles have an average diameter greater than 5 mm (0.2 inc.) 2. Said of a sedimentary rock, and of its texture, in which the individual constituents are easily seen with the unaided eye, i.e. have an average diameter greater than 2 mm (0.08 in.)

COARSE-TEXTURED - (light textured) SOIL - Sand or loamy sand.

COBBLE - A rock fragment between 64 and 256 mm in diameter, thus larger than a pebble and smaller than a boulder, rounded or otherwise abraded in the course of aqueous, eolian, or glacial transport.

CONE OF DEPRESSION - The depression of heads around a pumping well caused by the withdrawal of water.

CONFINED AQUIFER - An aquifer bounded above and below by impermeable beds, or by beds of distinctly lower permeability than that of the aquifer itself.

CONGLOMERATE - A coarse-grained sedimentary rock, composed of rounded pebbles, cobbles, and boulders, set in a fine-grained matrix of sand or silt, and commonly cemented by calcium carbonate, iron oxide, silica, or hardened clay.

CONSOLIDATION - Any process whereby loosely aggregated, soft, or liquid earth materials become firm and coherent rock; specif. the solidification of a magma to form an igneous rock, or the lithification of loose sediments to form a sedimentary rock.

CONTAMINANT - As defined by Section 101(f)(33) of Superfund Amendments and Reauthorization Act of 1986 (SARA) shall include, but not be limited to any element, substance, compound, or mixture, including disease-causing agents, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction), or physical deformation in such organisms or their offspring; except that the term "contaminant" shall not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under:

(a) any substance designated pursuant to Section 311(b)(2)(A) of the Federal Water Pollution Control Act,

(b) any element, compound, mixture, solution, or substance designated pursuant to Section 102 of this Act,

(c) any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act (but not including any waste the regulation of which under the Solid Waste Disposal Act has been suspended by Act of Congress),

(d) any toxic pollutant listed under Section 307(a) of the Federal Water Pollution Control Act,

(e) any hazardous air pollutant listed under Section 112 of the Clean Air Act, and

(f) any imminently hazardous chemical substance or mixture with respect to which the administrator has taken action pursuant to Section 7 of the Toxic Substance Control Act;

and shall not include natural gas, liquefied natural gas, or synthetic gas of pipeline quality (or mixtures of natural gas and such synthetic gas).

CREEK - A term generally applied to any natural stream of water, normally larger than a brook but smaller than a river.

CRITICAL HABITAT - The specific areas within the geographical area occupied by the species on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management consideration or protection.

CUESTA - An asymmetrical ridge, with a long, gentle slope on one side conforming with the dip of the underlying strata, and a steep or clifflike face on the other side formed by the outcrop of the resistant beds.

DEPOSITS - Earth material of any type, either consolidated or unconsolidated, that has accumulated by some natural process or agent.

DIP - The angle that a stratum or any planar feature makes with the horizontal, measured perpendicular to strike and in the vertical plane.

DOLOMITE - A sedimentary rock consisting of calcium magnesium carbonate, $CaMg(Co_3)_2$. Occurs in beds formed by the alteration of limestone.

DRAINAGE CLASS (natural) - Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

> *Excessively drained* - Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
>
> *Somewhat excessively drained* - Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
>
> *Well-drained* - Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well-drained soils are commonly medium textured. They are mainly free of mottling.
>
> *Moderately well drained* - Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained - Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained - Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough periods during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained - Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

DRAINAGEWAY - A channel or course along which water moves in draining an area.

DRUMLIN - A low, smoothly rounded, elongate hill of compact glacial till, or rarely other kinds of drift, built under the margin of the ice and shaped by its flow, or carved out of an older moraine by readvancing ice; its longer axis is parallel to the direction of movement of the ice.

ENDANGERED SPECIES - Any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the Class Insecta determined by the secretary to constitute a pest whose protection would present an overwhelming and overriding risk to man.

EROSION - The general process or the group of processes whereby the materials of the Earth's crust are loosened, dissolved, or worn away, and simultaneously moved from one place to another by natural agencies, but usually exclude mass wasting.

ESCARPMENT - A long, more or less continuous cliff or relatively steep slope facing in one general direction, separating two level or gently sloping surfaces, and produced by erosion or faulting.

FAULT - A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

FELDSPAR - Any of several crystalline minerals made up of Aluminum silicates with sodium, potassium, or calcium, usually glassy and moderately hard, found in igneous rocks.

FERRUGINOUS - Pertaining to or containing iron.

FINE-GRAINED - 1. Said of an igneous rock, and its texture, whose particles have an average diameter less than 1 mm (0.04 in.) 2. Said of a sedimentary rock, and of its texture, in which the particles have an average diameter less than 1/16 mm (62 microns, or silt size and smaller).

FINE-TEXTURED (heavy textured) SOIL - Sandy clay, silty clay, and clay.

FLOOD PLAIN - The surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks.

FOLD [geol struc] - A curve or bend of a planar structure such as rock strata, bedding planes, foliation or cleavage.

FORMATION - A lithologically distinctive, mappable body of rock.

FOSSILIFEROUS - Containing fossils.

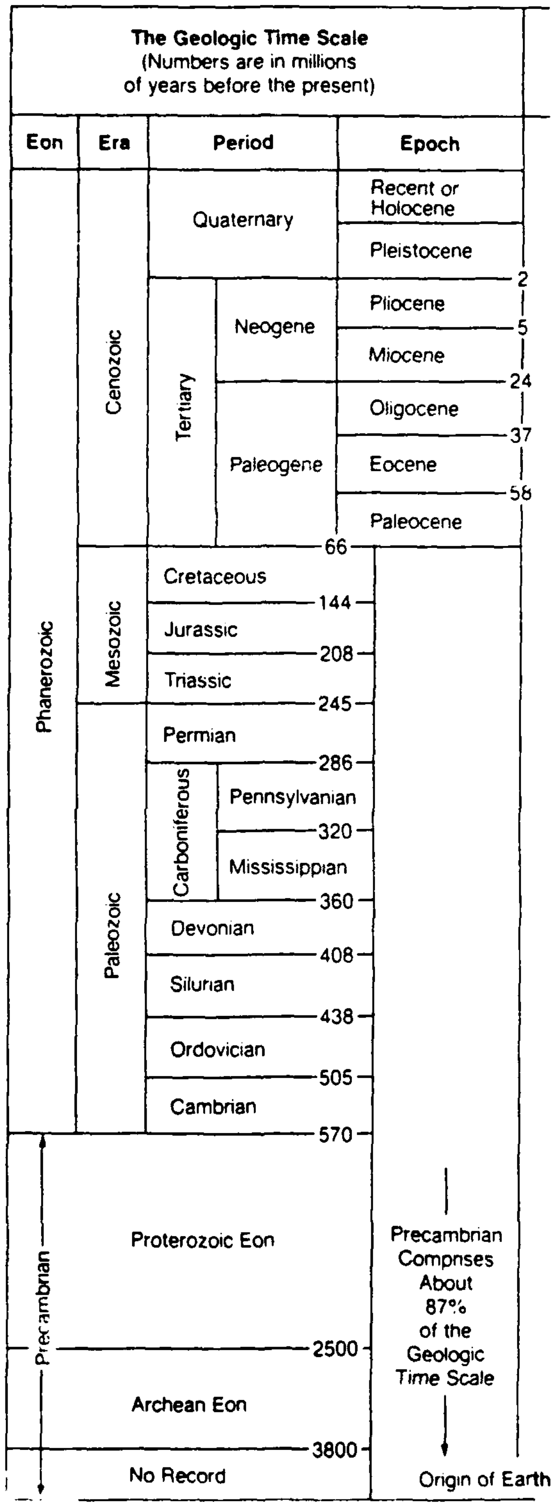
FRACTURE [struc geol] - A general term for any break in a rock, whether or not it causes displacement, due to mechanical failure by stress. Fracture includes cracks, joints, and faults.

GEOLOGIC TIME - See Figure Gl.1.

GLACIAL - (a) of or relating to the presence and activities of ice or glaciers, (b) Pertaining to distinctive features and materials produced or derived from glaciers and ice sheets.

GLACIAL DRIFT - A general term for drift transported by glaciers or icebergs and deposited on land or in the sea.

GLACIAL TILL - Unstratified drift, deposited directly by a glacier without reworking by meltwater and consisting of a mixture of clay, silt, sand, gravel, and boulders ranging widely in size and shape.



SOURCE: Wicander, R. and J. S. Monroe, Historical Geology Evolution of the Earth and Life Through Time, 1989.

Figure GI.1

The Geologic Time Scale

GLAUCONITIC SANDSTONE - greensand, composed of a green mineral, closely related to the micas and essentially a hydrous potassium iron silicate.

GRANITE - Broadly applied, any crystalline, quartz-bearing plutonic rock; also commonly contains feldspar, mica, hornblende, or pyroxene.

GRANODIORITE - A group of coarse-grained plutonic rocks intermediate in composition between quartz diorite and quartz monzonite, containing quartz, plagioclase, and potassium feldspar with biotite, hornblende, or more rarely, pyroxene, as the mafic contents.

GRAVEL - An unconsolidated, natural accumulation of rounded rock fragments resulting from erosion, consisting predominantly of particles larger than sand, such as boulders, cobbles, pebbles, granules or any combination of these fragments.

GROUNDWATER - Refers to the subsurface water that occurs beneath the water table in soils and geologic formations that are fully saturated.

HARM - Hazard Assessment Rating Methodology - A system adopted and used by the United States Air Force to develop and maintain a priority listing of potentially contaminated sites on installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts. (Reference: DEQPPM 81-5, December 11, 1981.)

HAS - Hazard Assessment Score - The score developed by using the Hazard Assessment Rating Methodology (HARM).

HAZARDOUS MATERIAL - Any substance or mixture of substances having properties capable of producing adverse effects on the health and safety of the human being. Specific regulatory definitions also found in OSHA and DOT rules.

HAZARDOUS WASTE - A solid or liquid waste that, because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

a. cause, or significantly contribute to, an increase in mortality or an increase in serious or incapacitating reversible illness, or

b. pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

HERBICIDE - A weed killer.

HILL - A natural elevation of the land surface, rising rather prominently above the surrounding land, usually of limited extent and having a well-defined outline (rounded) and generally considered to be less than 1000 feet from base to summit.

IGNEOUS ROCKS - Rock or mineral that has solidified from molten or partially molten material, i.e. from magma.

INTERBEDDED - Beds lying between or alternating with others of different character; especially rock material laid down in sequence between other beds.

KAME - A mound, knob, or short irregular ridge, composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a superglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

LACUSTRINE - Pertaining to, produced by, or inhabiting a lake or lakes.

LIMESTONE - A sedimentary rock consisting of the mineral calcite (calcium carbonate, $CaCO_3$) with or without magnesium carbonate.

LIMONITE - A common secondary material, formed by weathering (oxidation) of iron-bearing materials.

LITHOLOGY - (a) The description of rocks. (b) The physical character of a rock.

LOAM - A rich, permeable soil composed of a friable mixture of relatively equal proportions of sand, silt, and clay particles, and usually containing organic matter.

MEAN LAKE EVAPORATION - The total evaporation amount for a particular area; amount based on precipitation and climate (humidity).

MEDIUM-GRAINED - 1. Said of an igneous rock, and of its texture, in which the individual crystals have an average diameter in the range of 1-5 mm (0.04 - 0.2 in.) 2. Said of a sedimentary rock, and of its texture, in which the individual particles have an average diameter in the range of 1/16 to 2 mm (62-2000 microns, or sand size).

METAMORPHIC ROCK - Any rock derived from pre-existing rocks by mineralogical, chemical, and/or structural changes, essentially in solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment, generally at depth in the Earth's crust.

MIGRATION [Contaminant] - The movement of contaminants through pathways (groundwater, surface water, soil, and air).

MINERAL - A naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form and physical properties.

MORAINE - A mound or ridge of unstratified glacial drift, chiefly till, deposited by direct action of glacier ice.

NET PRECIPITATION - Precipitation minus evaporation.

NORMAL FAULT - A fault in which the hanging wall appears to have moved downward relative to the footwall. The angle of dip is usually 45° - 90°.

OUTCROP - That part of a geologic formation or structure that appears at the surface of the Earth.

OUTWASH [glac geol] - A stratified detritus (chiefly sand and gravel) removed or "washed out" from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of an active glacier.

OUTWASH PLAIN - a broad, gently sloping sheet of outwash deposited by meltwater streams flowing in front of or beyond a glacier, and formed by coalescing outwash fans.

PERMEABILITY - The capacity of a porous rock, sediment, or soil for transmitting a fluid without impairment by the structure of the medium; it is a measure of the relative ease of fluid flow under unequal pressure.

POND - A natural body of standing fresh water occupying a small surface depression, usually smaller than a lake and larger then a pool.

POROSITY - The ratio of the aggregate volume of interstices in a rock or soil to its total volume.

POTENTIOMETRIC SURFACE - An imaginary surface representing the total head of groundwater and defined by the level to which water will rise in a well. The water table is a particular potentiometric surface.

QUARTZ - A crystalline silica, an important rock forming mineral: SiO_2. Occurs either in transparent hexagonal crystals (colorless or colored by impurities) or in crystalline. Forms the major proportion of most sands and has a widespread distribution in igneous, metamorphic and sedimentary rocks.

RECHARGE - The processes involved in the addition of water to the zone of saturation; also, the amount of water added.

RIVER - A general term for a natural freshwater surface stream of considerable volume and a permanent or seasonal flow, moving in a definite channel toward a sea, lake, or another river.

SAND - A rock or mineral particle in the soil, having a diameter in the range 0.52 - 2 mm.

SANDSTONE - A medium-grained fragmented sedimentary rock composed of abundant round or angular sand fragments set in a fine-grained matrix (silt or clay) and more or less firmly united by a cementing material (commonly silica, iron oxide, or calcium carbonate).

SANDY LOAM - A soil containing 43 - 85% sand, 0 - 50% silt, and 0 - 20% clay, or containing at least 52% sand and no more than 20% clay and having the percentage of silt plus twice the percentage of clay exceeding 30% or containing 43 - 52% sand, less than 50% silt, and less than 7% clay.

SCHIST - A medium- or coarse-grained, strongly foliated, crystalline rock; formed by dynamic metamorphism.

SEDIMENTARY ROCK - A rock resulting from the consolidation of loose sediment that has accumulated in layers; e.g., a clastic rock (such as conglomerate or tillite) consisting of mechanically formed fragments of older rock transported from its source and deposited in water or from air or ice; or a chemical rock (such as rock salt or gypsum) formed by precipitation from solution; or an organic rock (such as certain limestones) consisting of the remains or secretions of plants and animals.

SHALE - A fine-grained detrital sedimentary rock, formed by the consolidation (especially by compression) of clay, silt, or mud.

SILT [soil] - (a) A rock or mineral particle in the soil, having a diameter in the range 0.002-0.005 mm; (b) A soil containing more than 80% silt-size particles, less than 12% clay, and less than 20% sand.

SILT LOAM - A soil containing 50 - 88% silt, 0 - 27% clay and 0 - 50% sand.

SILTSTONE - An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

SLATE - A compact, fine-grained metamorphic rock that possesses slaty cleavage and hence can be split into slabs and thin plates. Most slate was formed from shale.

SOIL PERMEABILITY - The characteristic of the soil that enables water to move downward through the profile. Permeability is measured as the distance per unit time that water moves downward through the saturated soil.

Terms describing permeability are:

Very Slow	-	less than 0.06 inches per hour (less than 4.24×10^{-5} cm/sec)
Slow	-	0.06 to 0.20 inches per hour (4.24×10^{-5} to 1.41×10^{-4} cm/sec)
Moderately Slow	-	0.20 to 0.63 inches per hour (1.41×10^{-4} to $4.45 \text{ X } 10^{-4}$ cm/sec)
Moderate	-	0.63 to 2.00 inches per hour (4.45×10^{-4} to 1.41×10^{-3} cm/sec)
Moderately Rapid	-	2.00 to 6.00 inches per hour (1.41×10^{-3} to 4.24×10^{-3} cm/sec)
Rapid	-	6.00 to 20.00 inches per hour (4.24×10^{-3} to 1.41×10^{-2} cm/sec)
Very Rapid	-	more than 20.00 inches per hour (more than 1.41×10^{-2} cm/sec)

(Reference: U.S.D.A. Soil Conservation Service)

SOLVENT - A substance, generally a liquid, capable of dissolving other substances.

SORTED - Said of a sediment or detrital rock consisting of uniform size of lying within the limits of a single grade.

STRATIFIED - Formed, arranged, or laid down in layers or strata; especially said of any layered sedimentary rock or deposit.

STRATIGRAPHIC UNIT - A body of strata recognized as a unit for description, mapping, or correlation.

STRIKE - The direction taken by a structural surface, e.g., a bedding or fault plane, as it intersects the horizontal.

STRUCTURAL - Of or pertaining to rock deformation or to features that result from it.

SURFACE WATER - All water exposed at the ground surface, including streams, rivers, ponds, and lakes.

SWAMP - An area intermittently or permanently covered with water, having shrubs and trees but essentially without the accumulation of peat.

TECTONIC - Pertaining to the forces involved in, or the resulting structures of, tectonics.

TECTONICS - A branch of geology dealing with the broad architecture of the outer part of the earth, that is, the major structural or deformational features and their relations, origin, and historical evolution.

TERRACE [geomorph] - Any long, narrow, relatively level or gently inclined surface, generally less broad than a plain, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope.

THREATENED SPECIES - Any species which is likely to become an endangered species within the foreseeable future throughout all or significant portion of its range.

THRUST FAULT - A fault with a dip of 45° or less over much of its extent, on which the hanging wall appears to have moved upward relative to the footwall. Horizontal compression rather than vertical displacement is its characteristic feature.

TILL - Dominantly unsorted and unstratified drift, generally unconsolidated, deposited directly by and underneath a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand and gravel and boulders ranging widely in size and shape.

TIME [Geologic] - See Figure Gl.1.

TOPOGRAPHY - The general conformation of a land surface, including its relief and the position of its natural and man-made features.

UNCONSOLIDATED - (a) Sediment that is loosely arranged or unstratified, or whose particles are not cemented together, occurring either at the surface or at depth. (b) Soil material that is in a loosely aggregated form.

VALLEY - Any low-lying land bordered by higher ground, especially an elongate, relatively large, gently sloping depression of the earth's surface, commonly situated between two mountains or between ranges of hills and mountains, and often containing a stream or river with an outlet. It is usually developed by stream or river erosion, but can be formed by faulting.

VOLCANIC - Pertaining to the activities, structures, or rock types of a volcano.

WATER TABLE - The upper limit of the portion of the ground that is wholly saturated with water; the surface on which the fluid pressure in the pores of a porous medium is exactly atmospheric.

WETLANDS - Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

WILDERNESS AREA - An area unaffected by anthropogenic activities and deemed worthy of special attention to maintain its natural condition.

Appendix A

Outside Agency Contact List

OUTSIDE AGENCY CONTACT LIST

1) City of Worcester
City Manager's Office
of Planning and Community Development
Environmental Planning Coordinator
405 Main Street, Suite 400
Worcester, Massachusetts 01608
David J. Dunham
(508) 799-1400

2) City of Worcester
Department of Parks, Recreation, and Cemetery
125 Green Hill Parkway
Worcester, Massachusetts 01605
Thomas W. Taylor
(508) 799-1190

3) City of Worcester
Department of Public Works
Commissioner
20 East Worcester Street
Worcester, Massachusetts 01604
Robert Maylan
(508) 799-1430

4) City of Worcester
Department of Public Works
20 East Worcester Street
Worcester, Massachusetts 01604
Hussein Haghanizadeh
(508) 799-1437

5) City of Worcester
Department of Public Works
Water Operations
18 East Worcester Street
Worcester, Massachusetts 01604
Michael Ferguson
(508) 799-1489

6) City of Worcester
Department of Public Works
Water Quality
37 Lee Street
Worcester, Massachusetts 01602
Phillip Jakubosky
(508) 799-8540

OUTSIDE AGENCY CONTACT LIST (continued)

7) Massachusetts Department of Environmental Management
100 Cambridge Street, 19th Floor
Boston, Massachusetts 02202
Bill Bones and Vicki Epstein
(617) 727-3267

8) Massachusetts Department of Environmental Quality Engineering
State Geologist
Executive Offices of Environmental Affairs
100 Cambridge Street
Boston, Massachusetts 02202
Joseph A. Sinnott
(617) 727-9800 Ext. 213

9) 104th Tactical Fighter Group
Barnes Air National Guard Base
Massachusetts Air National Guard
Westfield, Massachusetts 01085-1385
Major Gordon A. DuShane, Jr.
(413) 568-9151

10) Shrewsbury Water Department
100 Maple Avenue
Shrewsbury, Massachusetts 01545
Bob Tazeski
(508) 845-3413

11) United States Department of Agriculture
Soil Conservation Service
672-B Main Street
Holden, Massachusetts 01520
Ronald E. Thompson
(508) 829-6628

12) United States Geological Survey
Massachusetts Office - Water Resources Division
28 Lord Road, Suite 280
Marlborough, Massachusetts 01752
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(508) 485-6360

OUTSIDE AGENCY CONTACT LIST (continued)

13) United States Geological Survey
New England District Headquarters - Water Resources Division
10 Causeway Street, Room 926
Boston, Massachusetts 02222
David McCartney
(617) 565-6860

14) Waste Management of Central Massachusetts, Inc.
301 Southwest Cutoff
Worcester, Massachusetts 01604
Gretchen Grogan
(508) 755-7606

Appendix B

USAF Hazard Assessment Rating Methodology

USAF HAZARD ASSESSMENT RATING METHODOLOGY

The DoD has developed a comprehensive program to identify, evaluate, and control hazardous waste disposal practices associated with past waste disposal techniques at DoD facilities. One of the actions required under this program is to:

> Develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts (Reference: DEQPPM 81-5, December 11, 1981).

Accordingly, the USAF has sought to establish a system to set priorities for taking further action at sites based upon information gathered during the PA phase of the IRP.

PURPOSE

The purpose of the site rating model is to assign a ranking to each site where there is suspected contamination from hazardous substances. This model will assist the ANG in setting priorities for follow-up site investigations.

This rating system is used only after it has been determined that (1) potential for contamination exists (hazardous waste present in sufficient quantity), and (2) potential for migration exists. A site may be deleted from ranking consideration on either basis.

DESCRIPTION OF THE MODEL

Like the other hazardous waste site ranking models, the USAF's site rating model uses a scoring system to rank sites for priority attention. However, in developing this model, the designers incorporated some special features to meet specific DoD needs.

The model uses data readily obtained during the Preliminary Assessment portion of the IRP. Scoring judgment and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and worst hazards at the site. Sites are given low scores only if there are clearly no hazards. This approach meshes well with the policy for evaluating and setting restrictions on excess DoD properties.

Site scores are developed using the appropriate ranking factors presented in this appendix. The site rating form and the rating factor guidelines are provided at the end of this appendix.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: (1) possible receptors of the contamination, (2) the waste and its characteristics, (3) the potential pathways for contaminant migration, and (4) any effort that was made to contain the waste resulting from a spill.

The receptors category rating is based on four rating factors: (1) the potential for human exposure to the site, (2) the potential for human ingestion of contaminants should underlying aquifers be polluted, (3) the current and anticipated use of the surrounding area, and (4) the potential for adverse effects upon important biological resources and fragile natural settings. The potential for human exposure is evaluated on the basis of the total population within 1000 feet of the site, and the distance between the site and the base boundary. The potential for human ingestion of contaminants is based on the distance between the site and the nearest well, the groundwater use of the uppermost aquifer, and population served by the groundwater supply within 3 miles of the site. The uses of the surrounding area are determined by the zoning within a 1-mile radius. Determination of whether or not critical environments exist within a 1-mile radius of the site predicts the potential for adverse effects from the site upon important biological resources and fragile natural settings. Each rating factor is numerically evaluated (0-3) and increased by a multiplier. The maximum possible score is also computed. The factor score and maximum possible scores are totaled, and the receptors subscore computed as follows: receptors subscore = (100 X factor subtotal/maximum score subtotal).

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score while scores for solids are reduced.

The pathways category rating is based on evidence of contaminant migration along one of three pathways: surface water migration, flooding, and groundwater migration. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned, and for direct evidence, 100 points are assigned. If no evidence is found, the highest score among the three possible routes is used. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The scores for each of the three categories are added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Scores for sites with no containment are not reduced. Scores for sites with limited containment can be reduced by 5 percent. If a site is contained and well-managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the score for the other three categories.

HAZARD ASSESSMENT RATING FORM

NAME OF SITE

LOCATION ____________________

DATE OF OPERATION OR OCCURRENCE ____________________

OWNER/OPERATOR ____________________

COMMENTS/DESCRIPTION ____________________

SITE RATED BY ____________________

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1000 ft. of site		4		12
B. Distance to nearest well		10		30
C. Land use-zoning within 1-mile radius		3		9
D. Distance to installation boundary		6		18
E. Critical environments within 1-mile radius of site		10		30
F. Water quality of nearest surface water body		6		18
G. Groundwater use of uppermost aquifier		9		27
H. Population served by surface water supply within 3 miles downstream of site		6		18
I. Population served by groundwater supply within 3 miles of site		6		18

Subtotals ________ 180

Receptors subscore (100 x factor score subtotal/maximum score subtotal)

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) ________
2. Confidence level (C = confirmed, S = suspected) ________
3. Hazard rating (H = high, M = medium, L = low) ________

Factor Subscore A (from 20 to 100 based on factor score matrix)

B. Apply persistence factor
Factor subscore A x Persistence Factor = Subscore B

________ x ________ = ________

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

________ x ________ =

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore

B. Rate the migration potential for 3 potential pathways: Surface water migration, flooding, and groundwater migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water		8		24
Net precipitation		6		18
Surface erosion		8		24
Surface permeability		6		18
Rainfall intensity		8		24

Subtotals ________ 108

Subscore (100 x factor score subtotal/maximum score subtotal)

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
2. Flooding		1		3

Subscore (100 x factor score/3)

3. Groundwater migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to groundwater		8		24
Net precipitation		6		18
Soil permeability		8		24
Subsurface flows		8		24
Direct access to groundwater		8		24

Subtotals ________ 114

Subscore (100 x factor score subtotal/maximum score subtotal)

C. Highest pathway score

Enter the highest subscore value from A, B-1, B-2, or B-3 above

Pathways subscore

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors
Waste Characteristics
Pathways

Total ________ divided by 3 = ________

Gross Total Score

B. Apply factor for waste containment from waste management practices.

Gross Total Score x Waste Management Practices Factor = Final Score

________ x ________ = $\boxed{}$

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

1. RECEPTORS CATEGORY

Rating Factors	Rating Scale Levels 0	1	2	3	Multiplier
A. Population within 1,000 feet (includes on-base facilities)	0	1-25	26-100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land use/zoning (within 1-mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential	3
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E. Critical environments (within 1-mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of economically important natural resources susceptible to contamination	Major habitat of an endangered or threatened species; presence of recharge area; major wetlands	10
F. Water quality/use designation of nearest surface water body	Agricultural or industrial use	Recreation, propagation and management of fish and wildlife	Shellfish propagation and harvesting	Potable water supplies	6
G. Groundwater use of uppermost aquifer	Not used, other sources readily available	Commercial industrial, or irrigation, very limited other water sources	Drinking water, municipal water available	Drinking water, no municipal water available, commercial, industrial, or irrigation; no other water source available	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1-50	51-1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1-50	51-1,000	Greater than 1,000	6

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

S = Small quantity (5 tons or 20 drums of liquid)
M = Moderate quantity (5 to 20 tons or 21 to 85 drums of liquid)
L = Large quantity (20 tons or 85 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- o Verbal reports from interviewer (at least 2) or written information from the records
- o Knowledge of types and quantities of wastes generated by shops and other areas on base

S = Suspected confidence level

- o No verbal reports or conflicting verbal reports and no written information from the records
- o Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site

A-3 Hazard Rating

Rating Factors	Rating Scale Levels 0	1	2	3
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2	Sax's Level 3
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F	Flash point less than 80°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels	Over 5 times background levels

Use the highest individual rating based on toxicity, ignitability, and radioactivity and determine the hazard rating.

Hazard Rating	Points
High (H)	3
Medium (M)	2
Low (L)	1

II. WASTE CHARACTERISTICS--Continued

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
	L	C	M
80	M	C	H
70	L	S	H
	S	C	H
60	M	C	M
	L	S	M
	L	C	L
50	M	S	H
	S	C	M
	S	S	H
	M	S	M
40	M	C	L
	L	S	L
	S	C	L
30	M	S	L
	S	S	M
20	S	S	L

Notes:
For a site with more than one hazardous waste, the waste quantities may be added using the following rules:

Confidence Level
- o Confirmed confidence levels (C) can be added.
- o Suspected confidence levels (S) can be added.
- o Confirmed confidence levels cannot be added with suspected confidence levels.

Waste Hazard Rating
- o Wastes with the same hazard rating can be added.
- o Wastes with different hazard ratings can only be added in a downgrade mode, e.g., MCM + SCH = LCM if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an MCM designation (60 points). By adding the quantities of each waste, the designation may change to LCM (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Persistence Criteria	Multiply Point Rating From Part A by the Following
Metals, polycyclic compounds, and halogenated hydrocarbons	1.0
Substituted and other ring compounds	0.9
Straight chain hydrocarbons	0.8
Easily biodegradable compounds	0.4

C. Physical State Multiplier

Physical state	Multiply Point Total From Parts A and B by the Following
Liquid	1.0
Sludge	0.75
Solid	0.50

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, groundwater, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 Potential for Surface Water Contamination

Rating Factors	0	1	2	3	Multiplier
Distance to nearest surface water (includes drainage ditches and storm sewers)	Greater than 1 mile	2,001 feet to a mile	501 feet to 2,000 feet	0 to 500 feet	8
Net precipitation	Less than -10 inches	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches	6
Surface erosion	None	Slight	Moderate	Severe	8
Surface permeability	0% to 15% clay ($>10^{-2}$ cm/sec)	15% to 30% clay (10^{-2} to 10^{-4} cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	Greater than 50% clay ($<10^{-6}$ cm/sec)	6
Rainfall intensity based on 1-year, 24 hour rainfall (thunderstorms)	<1.0 inch 0-5 0	1.0 to 2.0 inches 6-35 30	2.1 to 3.0 inches 36-49 60	>3.0 inches >50 100	8

B-2 Potential for Flooding

Rating Factors	0	1	2	3	Multiplier
Floodplain	Beyond 100-year floodplain	In 100-year floodplain	In 10-year floodplain	Floods annually	1

B-3 Potential for Groundwater Contamination

Rating Factors	0	1	2	3	Multiplier
Depth to groundwater	Greater than 500 feet	50 to 500 feet	11 to 50 feet	0 to 10 feet	8
Net precipitation	Less than -10 inches	-10 to +5 inches	+5 to +20 inches	Greater than +20 inches	6
Soil permeability	Greater than 50% clay ($<10^{-6}$ cm/sec)	30% to 50% clay (10^{-4} to 10^{-6} cm/sec)	15% to 30% clay 10^{-2} to 10^{-4} cm/sec	0% to 15% clay ($>10^{-2}$ cm/sec)	8
Subsurface flows	Bottom of site greater than 5 feet above high groundwater level	Bottom of site occasionally submerged	Bottom of site frequently submerged	Bottom of site located below mean groundwater level	8
Direct access to groundwater (through faults, fractures, faulty well casings, subsidence, fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk	8

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. Waste Management Practices Factor

The following multipliers are then applied to the total risk points (from A):

Waste Management Practice	Multiplier
No containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- o Clay cap or other impermeable cover
- o Leachate collection system
- o Liners in good condition
- o Adequate monitoring wells

Surface Impoundments:

- o Liners in good condition
- o Sound dikes and adequate freeboard
- o Adequate monitoring wells

Spills:

- o Quick spill cleanup action taken
- o Contaminated soil removed
- o Soil and/or water samples confirm total cleanup of the spill

Fire Protection Training Areas:

- o Concrete surface and berms
- o Oil/water separator for pretreatment of runoff
- o Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1, or III-B-3, then leave blank for calculation of factor score and maximum possible score.

Appendix C

Site Hazard Assessment Rating Forms and Factor Rating Criteria

HAZARD ASSESSMENT RATING FORM

NAME OF SITE Old Embankment/Vicinity of Old Waste Oil Holding Area (Site No. 1)

LOCATION Center of Northwest Perimeter Fence

DATE OF OPERATION OR OCCURRENCE 1959 - 1990

OWNER/OPERATOR Worcester Air National Guard Station

COMMENTS/DESCRIPTION

SITE RATED BY Science & Technology, Inc.

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1000 ft. of site	3	4	12	12
B. Distance to nearest well	3	10	30	30
C. Land use-zoning within 1-mile radius	3	3	9	9
D. Distance to installation boundary	3	6	18	18
E. Critical environments within 1-mile radius of site	2	10	20	30
F. Water quality of nearest surface water body	0	6	0	18
G. Groundwater use of uppermost aquifier	2	9	18	27
H. Population served by surface water supply within 3 miles downstream of site	3	6	18	18
I. Population served by groundwater supply within 3 miles of site	3	6	18	18
		Subtotals	143	180

Receptors subscore (100 x factor score subtotal/maximum score subtotal) 79

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) S
2. Confidence level (C = confirmed, S = suspected) C
3. Hazard rating (H = high, M = medium, L = low) H

Factor Subscore A (from 20 to 100 based on factor score matrix) 60

B. Apply persistence factor
Factor subscore A x Persistence Factor = Subscore B

60 x 0.9 = 54

C. Apply physical state multiplier
Subscore B x Physical State Multiplier = Waste Characteristics Subscore

54 x 1.0 = 54

III. PATHWAYS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score

A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists, then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore 80

B. Rate the migration potential for 3 potential pathways: Surface water migration, flooding, and groundwater migration. Select the highest rating, and proceed to C.

1. Surface water migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Distance to nearest surface water	3	8	24	24
Net precipitation	2	6	12	18
Surface erosion	2	8	16	24
Surface permeability	1	6	6	18
Rainfall intensity	2	8	16	24
Subtotals			74	108

Subscore (100 x factor score subtotal/maximum score subtotal) 69

2. Flooding

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Flooding	0	1	0	3

Subscore (100 x factor score/3) 0

3. Groundwater migration

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
Depth to groundwater	2	8	16	24
Net precipitation	2	6	12	18
Soil permeability	2	8	16	24
Subsurface flows	0	8	0	24
Direct access to groundwater	2	8	16	24
Subtotals			60	114

Subscore (100 x factor score subtotal/maximum score subtotal) 53

C. Highest pathway score

Enter the highest subscore value from A, B-1, B-2, or B-3 above

Pathways subscore 80

IV. WASTE MANAGEMENT PRACTICES

A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors	79
Waste Characteristics	54
Pathways	80

Total 213 divided by 3 = 71

Gross Total Score

B. Apply factor for waste containment from waste management practices.

Gross Total Score x Waste Management Practices Factor = Final Score

71 x 1.0 = $\boxed{71}$

Worcester Air National Guard Station
Worcester, Massachusetts

USAF Hazard Assessment Rating Methodology
Factor Rating Criteria

The following is an explanation of the HARM factor rating criteria for the potential site:

I. Receptors

A. <u>Population Within 1000 feet of Site.</u>

Site No. 1, Factor Rating 3.
The weekend population of the Station is 433 persons.

B. <u>Distance to Nearest Well.</u>

Site No. 1, Factor Rating 3.
The nearest water well is located approximately 0.5 miles (2640 feet) south of the site.

C. <u>Land Use - Zoning (within 1-mile radius).</u>

Site No. 1, Factor Rating 3.
The area within a 1-mile radius of the site is predominantly residential.

D. <u>Distance to Installation Boundary.</u>

Site No. 1, Factor Rating 3.
The site encompasses the northwest boundary of the Station.

E. <u>Critical Environments (within 1-mile radius).</u>

Site No. 1, Factor Rating 2.
There are at least four small wetland areas within a 1-mile radius of the site. The closest two are the Bell Pond Wetland System and Green Hill Pond.

F. <u>Water Quality/Use Designation of Nearest Surface Water Body.</u>

Site No. 1, Factor Rating 0.
The nearest surface water body to Site No. 1 is the water fowl pond located immediately northwest of the Station and on the

grounds of the Green Hill Farm and Education Area. This pond is used to support farm birds.

G. Groundwater Use of Uppermost Aquifer.

Site No. 1, Factor Rating 2.
Although municipal water from surface water sources is readily available to the residents of Worcester, at least one domestic well taps the uppermost bedrock aquifer.

H. Population Served by Surface Water Supplies Within 3-miles Downstream of Site.

Site No. 1, Factor Rating 3.
According to information derived from the city of Worcester, approximately 150,000 residents of Worcester are supplied with surface water from Lake Quinsigamond.

I. Population Served by Aquifer Supplies Within 3-miles of Site.

Site No. 1, Factor Rating 3.
According to information derived from the city of Shrewsbury, an estimated 6000 persons within a 3-mile radius of the site are served by water supplies from aquifers.

II. Waste Characteristics

Site No. 1

A-1: Hazardous Waste Quantity - Factor Rating S (Small).
The quantities of hazardous wastes disposed of at this site are unknown. For calculation purposes, a small quantity is used.

A-2: Confidence Level - Factor Rating C (Confirmed).
This site was confirmed through interviews with six Station personnel.

A-3: Hazard Rating - Factor Rating H (High).
This site was given a high hazard rating because of the high toxicity and high ignitability of many of the wastes disposed of at this site.

B. Persistence Multiplier for Point Rating.

Site No. 1 was assigned a persistence multiplier of 0.9 based on the presence of JP-4, JP-5, and organic solvents. These materials correspond to the HARM category of "Substituted and Other Ring Compounds."

C. Physical State Multiplier.

A physical state multiplier of 1.0 was applied to this site because the substances disposed of were liquids.

III. Pathways Category

A. Evidence of Contamination.

Site No. 1 was given a score of 80 (Indirect Evidence) because it is greatly suspected of being a source of contamination. An oil sheen and some evidence of fading oil stains were observed at the site.

B-1. Potential for Surface Water Contamination.

- o Distance to Nearest Surface Water: Factor Rating 3. Site No. 1 is located within 500 feet of a drainage ditch or storm sewer.
- o Net Precipitation: Factor Rating 2. The average annual net precipitation is 18.59 inches for this site.
- o Surface Erosion: Factor Rating 2. There is moderate erosion of soil in the unpaved portions of the site.
- o Surface Permeability: Factor Rating 1. The surface permeability at Site No. 1 ranges from 4.45×10^{-4} to 4.24×10^{-3} cm/sec.
- o Rainfall Intensity Based on 1-Year, 24-Hour Rainfall: Factor Rating 2. The rainfall intensity in the Station area is 2.5 + inches.

B-2. Potential for Flooding.

Factor Rating 0. Site No. 1 is located beyond the 100-year flood plains of local streams.

B-3. Potential for Groundwater Contamination.

- Depth to Groundwater: Factor Rating 2. The depth to groundwater at Site No. 1 is estimated to be 30 to 50 feet.

- Net Precipitation: Factor Rating 2. The average annual net precipitation is 18.59 inches for this site.

- Soil Permeability: Factor Rating 2. Soil permeability at Site No. 1 ranges from 4.45×10^{-4} to 4.24×10^{-3} cm/sec.

- Subsurface Flows: Factor Rating 0. The bottom of Site No. 1 is greater than 5 feet above high groundwater level.

- Direct Access to Groundwater: Factor Rating 2. Because of extensive structural deformation in the region, fracturing of the bedrock beneath Site No. 1 is possible.

IV. Waste Management Practices Factor

A multiplier of 1.0 is applied to Site No. 1 because a portion of the site is uncapped by pavement.